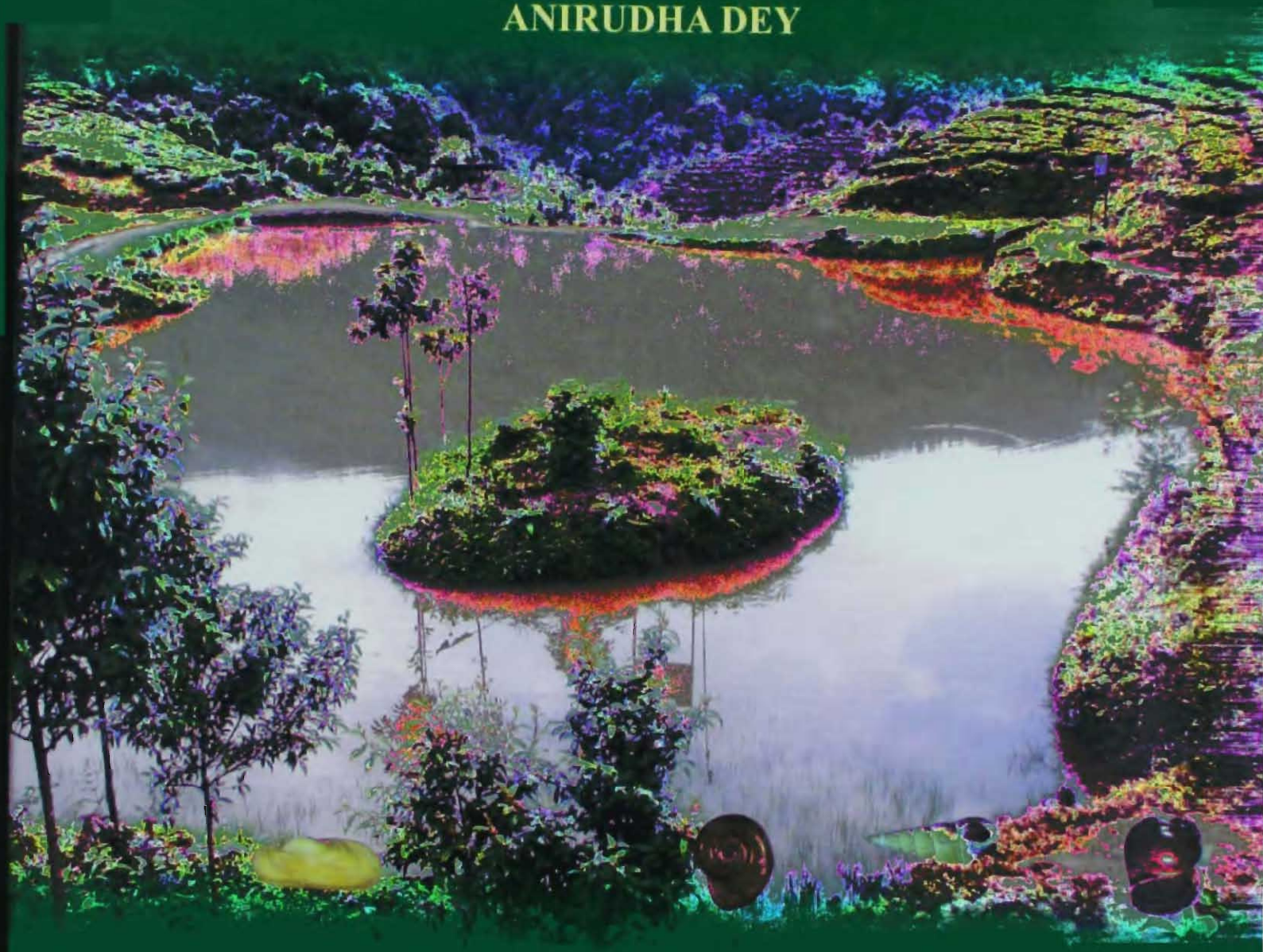
Handbook on

Indian Freshwater Molluscs

RAMAKRISHNA
ANIRUDHA DEY



ZOOLOGICAL SURVEY OF INDIA

Handbook on
Indian Freshwater Molluscs

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AICOPTAX-Mollusca
Zoological Survey of India
Kolkata

CITATION

Ramakrishna and Dey, Anirudha. 2007. *Handbook on Indian Freshwater Molluscs* : 1-399. (Published by the Director, *Zool. Surv. India,* Kolkata)

Published : May, 2007

ISBN 978-81-8171-146-5

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PRICE
Indian Rs. 1,500.00
Foreign : $ 75; £ 60

Published at the Publication Division by the Director Zoological Survey of India, 234/4, AJC Bose Road, 2nd MSO Building, 13th floor, Nizam Palace, Kolkata 700020 and printed at Power Printers, New Delhi 110 002.

PREFACE

Convention on biological diversity stipulates that the sovereign rights of the countries of origin over their genetic/biological diversity resources and acceptance of the need to share benefits flowing from commercial utilization of biological diversity resources with holders of traditional knowledge and practices of conservation and sustainable utilization of resources. In view of this, the conservation of biological diversity is a protective measure to prevent the loss of genetic diversity of the species, save the species from extinction, and to protect the ecosystems from damages. Criteria for assigning conservation priorities depends on the richness in a given area, the number of occurrence of the genotype, species or ecosystems (*Rarity*), degree of the separation of the population, species or ecosystems from its comparable analogue (*Distinctiveness),* degree of occurrence (*Representation*), imminent danger (*Threat*) and presence or absence of key stone resources (*Function*). It is therefore, high time that we reset our priorities and make an earnest effort to give due importance to research in Taxonomy. Before starting any kind of studies, one needs to know the correct scientific name of the organisms on which one is going to study. This is important because the correct scientific name of the organism is a functional label using which various pieces of information concerning that organism, including all the past work done on it, can be retrieved and stored ensuring easy reference (Narendran, 2000).

The need for a stronger focus on invertebrate conservation has long been recognized, but information on the status and distribution of the majority of invertebrates simply does not exist (Groombridge 1993). Invertebrates comprise a large proportion of biodiversity but are very rarely considered in reserve selection and other conservation initiatives. Molluscs represent one of the largest and most diverse phyla in the entire animal kingdom, next to the arthropods, they have the most named species in the animal kingdom (Hickman, 1961). Molluscs both extinct and living compromise about 11% of all animal species that have ever evolved during the entire course of earth history (Tasch, 1973). Recognizing the importance of molluscs (an invertebrate) in the life of humankind and the significant roles they play in ecosystems, the Mollusc Specialist Group (MSG) of IUCN believes that continuing loss of mollusc diversity is detrimental not only to ecosystems, but, in the long run, to the welfare of humankind itself. In this regard, inventorisation is considered important for assessment in evaluation of resources and their conservation options, which in turn rely on adequate use of taxic diversity. Therefore, the ultimate task of taxonomists is to document and understand the extent and significance of biological diversity.

Natural History Museums have long been recognized as the centres of systematics and biological research. The global biodiversity information is mainly based on the museum specimens, which form the baseline data on the diversity, distribution, abundance and

variation. The long association with vast authentically identified zoological collections present in the section of Zoological Survey of India, field survey experiences, association with colleagues exploring new resources of taxonomic characters, reflects the present state of our knowledge of freshwater molluscs in India. Therefore, the present book begins with the systematic survey of freshwater mollusks of India, including their ecology, distribution, values (food) and role in human welfare such as trematode infection in domestic cattle and man. The present form of this book includes a detailed account of the freshwater molluscs with key to the family, genera, and species besides geographical distribution and references. Attempts are not made to include all known synonyms, though in most cases these could be construed from the cited references. Wherever, possible, locations of the type species are given.

The work involves a team work for several months by various coworkers and expected to attract and enlighten the people from different walks of life.

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Place : Kolkata
May, 2007

ACKNOWLEDGEMENTS

The present state of this book would not have been possible without the active cooperation of the Secretary, Ministry of Environment & Forests, Government of India for the support and other assistance to the institution. The authors are thankful to Sri. B. S. Parsheera, Additional Secretary, Ms. Veena Upadhyaya, Joint Secretary, Dr. J. R. Bhatt, Director and Sri. M. S. Dawre, Additional Director, all Ministry of Environment & Forests, Paryavaran Bhawan, New Delhi for their constant encouragement.

The preparation of this publication has been made possible by prompt cooperation of the eminent malacologist such as Dr. N. V. Subba Rao, Sri. K.V. Surya Rao and Sri. S.C. Mitra. Assistance in various ways by the staff members of Mollusca section of Zoological Survey of India viz., Dr. R. Venkitesan, Sri. A.S. Barua, Sri. A.K. Mukherjee, Sri. Md. Hafeez and Ms. Abijna Ghosh, and to Mr. B.C. Halder, Photographer, is thankfully acknowledged.

Thanks are due to Mr. Rakesh Barman who assisted during the initial compilation and to Ms. Mitali Dey for the checking of the final manuscript, preparation of maps, plates and for other computer assistance rendered. Profuse thanks to Sri. Ratiram, Publication and Production Officer and the staff of publication wing of Zoological Survey of India for their untiring effort to bring this book in the present format.

Financial assistance under AICOPTAX : Mollusca of the Ministry of Environment and Forests is thankfully acknowledged.

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INTRODUCTION

Molluscs form the second largest group of animal after insects in the whole animal kingdom. They are highly adaptive and occupy all possible habitats except aerial. Originally marine, they have spread into freshwater and form there into the land, where they now almost equal the marine forms in species number. They are the most definitely characterised group in the animal kingdom, having at least two features, mantle and radula not found elsewhere. They are most part benthonic, but many have pelagic also. Primarily inhabitants of the intertidal and littoral zones of the ocean molluscs descend to great depths. A conservative estimate of species by Winckworth (cited by Eales, 1949) – 31643 marine, 8765 freshwater and 24503 land.

The freshwater molluscs play a vital role in the freshwater environment. They need to be considered as a part of whole freshwater community, particularly in its role in food chains linking upto the edible fish which are such an important resource of protein for human population. Not only many aquatic animals thrive on them but they also serve as food for human in many parts of the country. As vectors they are instrumental in the transmission of many diseases in livestock and human. They are the intermediate host of many trematodes, of which schistosomiasis is reckoned as a potential threat to human population. At other hand many larval bivalves are parasitic on gills of fishes.

The purpose of this book is to give a comprehensive systematic account of freshwater molluscs found in Indian subcontinent. The variety of information accumulated from different publications covers taxonomy, ecology, bionomics and distribution of freshwater molluscs and indicates the parts they play in the life cycle of trematodes parasities.

It is very difficult to define physiological limits for freshwater fauna. Many species included which freshwater biologists might encounter near estuaries or in coastal lagoons. In India there are many estuaries, backwaters and salt water lakes where salinity very less especially during the rainy season, may dominant by the freshwater fauna.

The study of freshwater molluscs began nearly two hundred years ago and took the direction of the paths taken by European traders and explores penetration of this sub continent. Not with standing the role of freshwater molluscs in aquatic ecosystem they are less explored ecologically and biologically. A perusal of literature shows a paucity of information on several aspects of these molluscs. Preston (1915) published the fauna of British India (Freshwater Gastropoda and Pelecypoda) and gave a comprehensive account of freshwater molluscs. Since than a vast amount of knowledge has been

accumulated on the freshwater molluscs. A number of new species, new excellent information on their biology, bionomics and distribution have been added. A good taxonomic account was given by different authors, but at the same time much confusion was created by addition of several isolated and inadequate description of species, as the types of many species are not available for study. Subba Rao (1989) published a "Handbook on Freshwater Molluscs of India" giving a consolidated account of freshwater molluscs which serves as a guide. This work needs revision and to up to date the present knowledge of freshwater molluscs of India this work was needed.

The freshwater molluscs are distinguished into two group's viz. Primary freshwater and secondary freshwater. The primary freshwater molluscs are confined exclusively to freshwater. There are some species primarily inhabitant of estuarine water extending to freshwater as secondary species. There are many species which are distributed both in estuaries and freshwaters. The genera like *Neritina, Septaria, Clithon* of gastropods and *Scaphula, Novaculina* of bivalves comes under this category. The genus *Thiara* primarily a freshwater form can tolerate the saline water. The families Assimineidae, Stenothyridae, Iravadiidae are primarily estuarine species occasionally found in freshwater. The bivalves genera *Polymesoda, Batissa, Vellorita* and *Tanysiphon* are primarily estuarine are rarely occurs in freshwater. Some species included in this book may not be freshwater.

This book begins with a systematic survey which includes information about ecology, distribution, edible form and parasites. These topics are enlarged upon in the subsequent chapters, which deals in more details. The systematic part of this book may appear incongruous beside sections, which deal with living snails.

The authors have examined the large number of named, unnamed and type collections present in National Zoological Collection of Zoological Survey of India and also carefully gone through the literature of freshwater molluscs mainly from Indian subcontinent. The first few chapters give an idea of general structure, bioecology, method of collection, food value, medical importance, snail born diseases. Keys have been provided to identify the families and subfamilies, genera and subgenera under respective families and key to species under genera where having more than one species. The systematic account of each species provided with synonymy, diagnosis, type location, distribution and illustrated by map and photographs or figures.

This book deals with 199 species belongs to 59 genera 29 subgenera under 26 families from Indian subcontinent. Among these nineteen families belongs to gastropod of which families Viviparidae, Ampullariidae, Valvatidae, Bithyniidae, Iravadiidae, Thiaridae, Pleuroceridae, Lymnaeidae, Physidae, Planorbidae, Bullinidae and Ancylidae are freshwater families. Families Neritidae and Littorinidae are marine whereas the families Stenothyridae, Assimineidae and Hydrobiidae are estuarine families. Pomatiopsidae a freshwater family extends to the terrestrial habitat.

ABBREVIATION USED

ANSP : Academy of National Sciences, Philadelphia

MNHN : Museum D'Histoire Naturelle, Paris

USNM : United States Natural History Museum, Washington

ZSI : Zoological Survey of India

Redg. No. : Registratrion Number.

MOLLUSCA

Molluscs are bilateral coelomate animals, often secondarily altered to asymmetrical condition, without or rarely with evident of metamerism, soft bodies animals, covered with shell of one or more than one pieces secreted by the mantle or pallium (a fold of body wall); neutral body wall modified to a muscular locomotory organ (foot); pharynx commonly provided with toothed band the radula and with gills, open circulating stem and meta nephridia.

General characters : It is a specialised group of the animal kingdom having at least two features- mantle and radula not found elsewhere. A typical mollusca possesses a head (wanting in bivalves) bears a terminal mouth, eyes, tentacles and often sensory organs; a muscular foot for locomotion; posterior dorsal visceral mass containing most of the viscera; a fold of body wall (mantle) that leaves between itself and the main body mass a cavity (mantle cavity); into which opens the termination of digestive, nephridial and reproductive system; houses the gills; and a external shell secreted by the mantle that partly or wholly encloses the soft body.

Besides these all foregoing characters molluscs have several structural plans that justify the division of the phylum into classes. Aplacophora or solenogasters the worm like animals with poorly differentiated head and the shell is replaced by a coat of calcareous spicules. Polyplacophora (Chiton) have a distinct head but lack eyes and tentacles and the shell is composed of a series of eight valves. Monoplacophora resemble with limpets of class gastropoda, differs in the metameric repetition of several parts. Gastropoda (Snail) with well developed head and a spirally coiled univalve shell are usually taken represented as typical molluscs.

Pelecypoda (Bivalves) lacks of head and radula and is completely enclosed by a pair of lateral shell. Scaphopoda (Tusk shells) has a poorly differentiated head, lacks gills, and is enclosed in a tusk shaped shell with apical openings. Cephalopoda, the most divergent group includes *Nautilus, Octopus* and *Squids* highly specialised molluscs with foot altered into a circlet of arms provided with suckers.

The soft body of molluscs are commonly protected by an exoskeletal calcareous covering termed as shell, a very important character for the identification. It may consist of one spirally coiled shell (Gastropoda), elongate tusk like valve (Scaphopoda), a pair of valves (Bivalvia) and a linear row of eight valves (Chitons). The shell is secreted by the dorsal epidermis, especially the outer epidermial fold of body wall known as mantle or pallium. It consists of a thin, organic outer layer known as periostracum; overlying a thick layer of calcium carbonate. Aplacophora lack a distinct shell, whose place is taken by a protective coat of calcareous spicules. Shell is also wanting in many gastropods or are greatly reduced and embedded in the body wall. In Cephalopods only the Nautiloids have a well developed spiral shell and in all others the shell is reduced and embedded in the mantle or wanting.

Molluscs is a very highly specialized group of animals having a distinct head bearing mouth, eyes, tentacles and other sensory organs. Eyes and tentacles are absent in Polyplacophora and Bivalves have altogether lost the head due to adaptation to sedentary habits. Typically ventral body wall is altered into a muscular, flat or plaugh like foot modified for numerous adaptations. The most important modification occurs in Cephalopods in which the foot becomes subdivided into numbers of arms that migrate to surround the mouth. The body wall is clothed with one layered often ciliated epidermis with mucocytes and other gland cells and is often invaginated to form sub epidermal glands. Definite sub epidermal muscle layers are often wanting but the whole animal is strongly muscularised with fibers running in all directions. The muscle fibers are of smooth type.

The digestive tract runs from the anteriorly located mouth to posterior anus; but in gastropods, scaphopods and cephalopods the intestine bends anteriorly bringing the anus to anterior position. Pharynx is with a radular mass, a complex of muscles and chondroid tissue which support and operate the radula, the characteristics molluscan feature formed by toothed chitinous ribbon, used to rasp the food. The radula is absent in bivalves. The buccopharyngeal region receives the secretion of salivary gland and a large midgut gland, probably originally paired, discharges into the stomach. The stomach is provided with crystalline style in monoplacophorans, bivalves and some gastropods and in Nautilus.

The respiratory organs typically consist of the gills (ctenidia), composed of a succession of thin leaflets, enclosing spaces in which the blood flows for aeration. The gills are of two types external and internal. External gills, usually numerous, are located in the mantle groove found in chitons, monoplacophorans and few gastropods. Internal gills are present in the mantle cavity, one pair (Nautilus); in most gastropods the right gill less disappeared in correlation with the loss of right auricles.

The circulatory system is open type except in cephalopods where it has a tendency towards a closed system. Heart enclosed in pericardial cavity, situated dorsally at the anterior end of the visceral mass. Typically it consists of two auricles and ventricles,

but in Neopilina it has two pairs of auricles and two ventricles. Two pairs of auricles are also present in the case of Nautilus. Lower gastropods possess two auricles, but the right one degenerates and only the left remains in most gastropods. Heart gives off and receives main vessels but between these the circulation is completed in sinuses, and the spaces in the connective tissues. The blood contains a copper compound haemocyanin the oxygen carrying pigment of molluscs; haemoglobin is rarely present.

The nervous system is less modified and consists of a circumcentric ring from which spring two pairs of longitudinal cords, lateral (or pleurovisceral) and pedal connected by numerous transverse commissures and giving off numerous lateral branches. The circumcentric ring encircles the buccal capsule and typically presents three pairs of ganglia, a pair each of cerebral, pleural and pedal ganglion. There is also present a pair of visceral ganglia. The mollusc there is evident on evolutionary concentration and enlargement of main ganglia concomitant with the progress of cephalisation. The process maximum in cephalopods where a large nervous mass, scarcely separable into ganglia, surrounds the beginning esophagus.

Mollucs do not have a coelom. The space between the digestive tract and body wall is filled with muscle fibers, connective tissue, and blood sinuses. True coelom is limited to pericardial cavity and the lumina of the gonad and nephridia. The coelom is more extensive in *Neopilina* comprising of a pair of pericardial sacs, the nephridial and gonodial lumina and dorsal coelomic sacs not found in other molluscs.

The excretory system consist of a pair of metanephridia which are true coelomoducts, extending from the pericardial cavity into which they open by a nephrostome to an external nephridiopore. *Nautilus* has two pairs of nephridia and *Neopilina* six pairs, each of which open internally into dorsal coelomic sacs and the two posterior pairs into the pericardial sacs. In gastropods that retain only one gill, osphradium etc also only one nephridium is retained as such; remnants of the others are incorporated into the gonoduct.

Molluscs are generally dioecious but hermaphroditism obtains in pulmonates, opisthobranchs, prosobranchs and some solenogasters and bivalves. In hermaphrodites eggs and sperm may be produced by the same gonad throughout or in separated parts designated separately as ovaries and testes. A pair of symmetrical gonads occurs in solenogasters and bivalves but in all others molluscs the gonads is single except monoplacophorans where the pairs of gonads are indicated. The sex cells are shed directly into sea water where fertilization takes place (solenogasters, chitons, marine bivalves, scaphopoda and lower marine gastropods) or following internal fertilization are deposited in gelatinous masses or enclosed in capsules or brooded in the female body. Cleavage is spiral determinate type except in cephalopods which lay large yolky eggs where meroblastic type of cleavage occurs. Spiral cleavage results in a trochophore larva which in marine bivalves and gastropods develops further into a characteristics larva veliger by extension of the ciliary girdle into large ciliated swimming lobes. Torsion

occurs in larval gastropods by the 180 degree rotation of the visceral mass while head and foot remain fixed. The cause and advantage of torsion remain problematical. According to Garstang (1928) the torsion first occurred as a larval mutation is of advantage to larva but not in the adult. He considered that the primitive posterior position of mantle cavity is disadvantageous to the larva in that there is no place into which the delicate head and velar lobes can be withdrawn in event of danger. By torsion the mantle cavity is brought around to the posterior end, providing a refuge for the parts in question. But the anus and nephridiopores are brought into an anterior position where they discharge at the animal's head. Gastrang suggested that this difficulty was partly met by the retreat of the anal and nephridial openings along the shell slit. However such a slit occurs only in a limited number of snails. The actual mechanism of torsion is thought to be the asymmetrical position and pull of the muscles that run from the velar lobes to the larval shell. Apparently some degree of asymmetry existed prior to torsion. Hescheler (1900) show stages of torsion and elucidate the crossing of pleurovisceral commissures. By torsion the pallial organs originally on the left side are brought to right side, where they tend to reduce or disappear. Torsion must be disadvantageous to adult snails as many of them undergo detorsion. As a result the pallial complex travels back towards the posterior end along the right side, the ctenidia point backwards, the auricle more behind the ventricle, and the visceral loop becomes untwisted and symmetrical. In this way a secondary external symmetrical is re-established. In Pulmonata detorsion is not complete so that the visceral loop remains partly twisted and the anus and ctenidium are directed laterally, instead of anteriorly. Total detorsion is found in opisthobranchiates by a reduction or disappearance of shell. In extreme cases the mantle and the visceral sac disappear.

CLASSIFICATION

Class GASTROPODA

Subclass PROSOBRANCHIA

Order ARCHAEOGASTROPODA

Superfamily NERITOIDEA

Family NERITIDAE

Family SEPTARIIDAE

Order MESOGASTROPODA

Superfamily VIVIPAROIDEA

Family VIVIPARIDAE

Family AMPULLARIIDAE

Superfamily VALVATOIDEA

Family VALVATIDAE

Superfamily LITTORINOIDEA
Family LITTORINIDAE
Superfamily RISSOIDEA
Family HYDROBIIDAE
Family BYTHYNIIDAE †
Family POMATIOPSIDAE
Family STENOTHYRIDAE
Family IRAVADIIDAE
Family ASSIMINEIDAE
Superfamily CERITHIOIDEA
Family THIARIDAE †
Family PLEUROCERIDAE
Subclass PULMONATA
Order BASOMMATOPHORA
Superfamily LYMNOIDEA
Family LYMNAEIDAE †
Superfamily PHYSOIDEA
Family PHYSIDAE
Superfamily PLANORBOIDEA
Family PLANORBIDAE †
Family BULINIDAE
Family ANCYLIDAE †

Class BIVALVIA
Subclass PTERIOMORPHIA
Order ARCOIDEA
Family ARCIDAE
Subclass PALEOHETERODONTA
Order UNIONOIDA
Superfamily UNIONOIDEA
Family UNIONIDAE
Superfamily MUTELOIDEA
Family ETHERIIDAE
Subclass HETERODONTA

Order VENEROIDA
Superfamily SOLENOIDEA
Family CULTELLIDAE
Superfamily TELLINOIDEA
Family PSAMMOBIIDAE
Superfamily CORBICULOIDEA
Family CORBICULIDAE
Family PISIDIIDAE

† Intermediate hosts for Trematods

ECOLOGY

The ecology of majority of Indian freshwater molluscs is still unknown. Biological studies of limited species of Viviparidae, Thiaridae and Ampullariidae were made by Annandale (1921); Annandale and Sewell (1921); Jacob (1958); Muley (1977); Prashad (1925, 1928) and Ramamoorthi (1950, 1955).

Freshwater molluscs in India inhabit all types of aquatic bodies being found in ponds, lakes, ditches, irrigation canals, streams and rivers with or without vegetation, with or without boulders etc.

Broadly the freshwater habits can be grouped into two categories such as ponds, ditches, paddy field etc. with more or less stagnant water (lentic type) and streams, rivers and canals with flowing waters (lotic type). The composition of the fauna of stagnant water differs from that of the fauna of flowing water. The streams of hills with higher elevation have different fauna than that of streams of plain. In this respects the streams of Nilgiris and Western Ghats have a very characteristics fauna. In general the snails belongs to the families Neritidae, Littorinidae, Ancylidae, Thiaridae are found in streams and small rivers whereas the members belonging to the families Viviparidae, Ampillariidae, Planorbidae and Lymnaeidae lives in stagnant water. Gastropods in general are found attached to the submerged vegetation, rocks or the substratum of the water bodies, crawling on the mud but the bivalves are found buried partly or wholly in the muddy or sandy bottom of the aquatic bodies. The freshwater molluscan shells exhibit a great variation depending on the ecology of the species and many produce ecophenotypes.

In the tropical countries the freshwater molluscs usually face an annual dry season. The gastropod and bivalves show varying capacity to survive in dry season. Many members can overcome this situation by aestivation them under dead vegetation or debris or by actively burrowing at least the aperture of the shell in the mud. Some of

gastropod members are capable for anaerobic respiration. During the unfavourable conditions the molluscs remain inactive and resume the normal life again as soon as the condition becomes favourable. The transient and discontinuous nature of freshwater bodies of India leads to the isolation of molluscs into small local population.

COLLECTION AND PRESERVATION

Molluscs are conspicuous and abundant in any productive aquatic ecosystem and can be considered as treasures within arms reach. Those engaged in freshwater molluscs collection will come across individual/population belonging to the class Gastropoda and Bivalvia. Two factors are importent to be a good collectors : i) forehand knowledge of habitat and habitats of molluscs; ii) a sensible and suitable choice of collecting equipments. These, together with a large measure of patience and perseverance will open up unlimited possibilities of acquiring a beautiful and complete collection.

Freshwater molluscs broadly occurs under two environments lentic and lotic. In general gastropods occur in the littoral region attached to vegetation or under stones. Bivalves are benthic forms, lived partly buried in the soft mud. They may be absent in the pond or tank having to hard or to soft bottom. There are certain freshwater molluscs with restricted distribution which occur in specific geographic areas of India. A search of aquatic vegetation of the ponds or tanks may be rewarded with gastropods. Most of the molluscs can easily be recognised by naked eye in the habitat of their natural occurrence. Although the aquatic body with vegetation may support some molluscs, the streams of Western Ghats, North-eastern India and Andaman and Nicobar Island are favourite habitats of Neritids, Melanids (including *Paludomus*) among gastropods. There are certain bivalves like freshwater oyster, (*Pseudomulleria, Arcidopsis*) restricted to Western Ghat and *Solenaia* restricted to Northeastern India.

Collection

Most of the molluscs are sufficiently large conspicuous and can easily be picked up. A hand net or water net fitted with a wooden handle is useful to drag over the aquatic vegetation, and when filled with aquatic weeds the contents are poured out on a spread out cloth piece. The leaves and branches of the plant carefully searched out and the snails are picked up with hand or forceps. Small specimens such as *Gyraulus* and others can be removed with the help of a brush. It may be necessary to wash the weed and an enamel tray is very useful for the same. The specimens are then transferred to specimen tubes or bottles. All the relevant data should be noted down in the field into a note book or data sheet.

Bivalves can be collected by dredge. By hand picking in case of bigger specimens from the bottom of small ponds or slow moving streams. Pea clams and other bivalves are collected from ponds and tanks, big streams or river with the help of hand dredge

or dredge operated from a boat. In small stream ponds the collection may be made by scooping the bottom mud and then put into the ordinary sieve and washed with water. After washing the small bivalves like *Pisidium, Shpaerium* can be easily picked up from the sieve.

Fixation and Preservation

For Routine studies : Identification of molluscs is mainly based on shell characters and in a few cases on radula and another anatomical structure, especially Lymnaeidae. Therefore it is very essential to preserve the molluscs shell as well as the soft part for better studies.

The aquatic molluscs collected are placed in enamel tray with some water. Menthol/ Magnesium sulphate/Chloral hydrate should be sprinkled over the water surface and the specimens left for 24 hrs. Freshwater snails and bivalves can be relaxed by plunging them into boiling water.

Sodium pentabarbitone (Nembutal) is also useful for preservation, 0.08% of Nembutal may be used and the animals allowed to relax.

After narcotization specimens are thoroughly washed and may be preserved in spirit or 70% alcohol. It is not advisable to preserve shell molluscs in formalin.

For anatomical or histological studies the animals are either fixed in Bouin's fluid or Carnoy solution. Time of fixation 24hrs and then the animal is washed and kept in 70% alcohol for further studies.

While preserving some shells with the animal intact, a few dry shells may be preserved. The freshwater snails are kept in boiling water for a few minutes and then the animal can be extracted from the shell with a bent tipped forceps. The empty shells are further cleaned and dried in air. In case of operculates the operculum should be retained by pushing it to a cotton plug inserted into its aperture.

Labeling : Shells or specimens without the relevant data are of a very little scientific value. Therefore the collections should be preserved with relevant data, namely locality (specifying the habitat), date of collection, collectors name etc.

Packing and Dispatch : When shells are sent to specialists for identification it always include the full collection data inscribed on a label and enclosed in each lot. Large specimens may be wrapped with cotton and packed. Polythene bags, wooden boxes or tin containers of suitable size with proper lining of paper or cotton and thermocole are suitable for packing to prevent the damage during transit. When the wet collections are packed in the container, tubes or bottles, they should be sealed properly preferably by wax to prevent the leakage and then packed with polythene bag and finally with a hard container.

For Quantitative Studies : Sampling methods, which give reliable estimate of number of individual organisms are very important for a freshwater biologist to study the productivity, population dynamics and the effect of population. It is evident that no single technique is suitable for this purpose. The choice of method being dependant on the objectives of study, the nature of the habitat and the facilities and personnel available.

Estimations of number of snails present in a locality at a particular time depending on counting of sample taken from known area or volume of habitat. A standard Ekman sampler is useful for collection of bottom deposits of lake, but potential disadvantage of this sampler is that the large snails or bivalves may hinder the jaws for closing properly. Tube sampler to estimate number of snails on the substratum of and irrigation channel, but is unsuitable for obtaining egg capsule and young snails. A drag scoop is capable of making quantitative samplings for ponds with sloping banks and irrigation channels.

To calculate the accurate number of snails present, the samples can be made from all recognisable biotopes of a locality and to estimate the proportional representation of each biotope within the whole habitat. For getting high accuracy it is essential to take large number of sampling from natural habitat, which may disturb the ecology of snail.

In large habitats however, the regular collections can be made from fixed stations. Collection made with scoop or dip net may provide the data for making satisfactory calculations of population dynamics, providing the mesh is fine enough to catch snails of wide size range. By comparing size distributions between the successive samples (within a period of intervals) the growth of particular cohorts of snail (groups of individuals born with the period) can be followed and data obtained for calculating size/ age relationship. This estimates the age for calculations of population dynamics and ideally a sample is discred in which eggs as well as snails of all different size are represented.

For chromosome studies : To study the chrosomes the acetic-orcein squash of the ovo-testis tissue of snails is required. This may be fixed in Carnoy solution (absolute alcohol, chloroform and acetic acid 3 : 2 : 1). Preserved or fresh dissected ovo-testis tissue is placed in a drop of acetic-orcein stain (1% of orcein in 45% of acetic acid) on a micro slide and teased into small pieces with fine needles. A cover slip is placed in position and heavy pressure is applied with the thumb through folded filter paper. In this temporary preparation chromosomes are most readily counted in diakinesis figure using green filter in light source of the microscope (Buch, 1960). Lufly and Demian used Feulgen technique in which pieces of fresh ovo-testis are placed in distilled water for 15 minutes, fixed in acetic acid (45 minutes) and then placed in micro slide covered with cover slip and squashed by adding pressure. The slide then placed in distilled water until the cover slip dropped off and hydrolysis is then performed in HCl (17-19 minutes) at 58^{0}C. Preparations are then dipped in distilled water and stained with Feulgen for one hour, dehydrated with different grades of alcohol and mounted with balsam.

Chromosomes can be clearly seen in preparation of young embryos in which mitosis has been blocked by use of colcemid (Claughter, 1971). Egg capsules with young embryos are placed in 2 ml of water for 30 minutes and 0.1 ml of colcemid solution is added (10μg/litre of water). Embryos are extracted from the capsules with needles, pipetted into a micro slide and squashed in acetic orcein.

Biochemical and immunological techniques

Wright (1973) and Davis (1978) applied some specialised techniques for taxonomic studies. Some of the methods have become sufficiently established to apply as routine adjuncts to other lines of taxonomic studies.

a) Chromatographic methods : Paper chromatography in a Kawerau dish using butanol acetic acid water applied on body surface mucus of *Lymnaea* (Wright, 1959), Chromatograms viewed in ultra violet light shows a series of fluorescent bands of various colours and intensities and specific pattern were recognised. Wright (1964) made an exhaustive study of intra specific variation in *Lymnaea peregra* and two points had immerged from the study. The first is that some biochemical variation between populations of single species may be greater than the differences between populations belonging to different species. Secondly the degree of intra population variation within the range of a species may be far from uniform, so that false conclusions could be drawn by sampling only a small part of the range of a widespread species.

b) Electrophoresis methods : Davis (1978) used the electrophoresis of proteins in molluscan taxonomic studies. A foot muscle has provided the source of unidentified proteins from prosbranch (Davis and Lindsay, 1964) while egg protein from perivitelline fluid has been studied, usually by electrophoresis in cellulose acetate. It is possible to quantify the results from this system and better resolution obtainable with isoelectric focusing (Saladin *et al.*, 1976).

Isoelectric focusing is a preferable technique to recognize the maximum number of isoenzymes in particular systems (Ross, 1977).

c) Immunological methods : In most of immunological studies of freshwater snails either egg protein or foot muscles proteins have been used as antigen. Eggs proteins were used as antigens to determine the relationship of species of certain affinities (Wright, 1971). A micro-Ouchterlony absorption method using antisera to foot muscle proteins gave identity reactions between populations of *Bulinus* having the same number of chromosomes whereas snails with different number of chromosomes gave non identity reactions (Burch and Lindsay, 1970).

Extracts from a number of species of freshwater snails have been found to agglutinate erythrocytes of vertebrates. Basing on few reports it is not possible to conclude that occurrence of agglutinins is a guide to taxonomic relationships. Indeed

they are known to be present or absent in different populations of the same snail species, yet this very diversity possibly could provide genetic markers in breeding experiments.

POTENTIAL RESOURCES OF AQUACULTURE

In the last few decades there has been unprecedented increase in uses of natural living resources by men, due to rise in the population. To improve the dietary standard of human beings and to meet the demand of world protein the aquaculture has been conceived and developed. "Kyoto declaration on aquaculture" as been a significant step for aquaculture promotion. Sophisticated aquacultural practice has substantially increased the global production. Aquaculture techniques are useful to increase the food production and conservation of certain economically important species. Aquaculture production constitutes fishes (66%), seaweed (17.5%), molluscs (16.2%) and crustaceans (0.3%). Altogether fishes constitute the major components of aquaculture; molluscs have a good role in the production of aquaculture. Out of total global molluscan catch 4,950,718 tonnes, Oysters (972,885 tonnes), Mussels (613,965 tonnes), Scallops (364,173 tonnes), Claim (1,176,771) and Cephalopods (7,572,098 tonnes). Molluscs are also cultured for the production of luxury items, such as pearls. Aquaculture may be the answer of starved masses and for the retrieval of over exploited natural shell resources. An increase in the shell production can augment our protein rich food supply. Cultivation of molluscs at present carried out mostly through coastal aquaculture. But from the data collected during our surveys there is a scope to take up of farming of molluscs in freshwater aquaculture as well.

BACKGROUND INFORMATION

The freshwater aquaculture is important in the development of additional food resource for the increasing human population of our country. Inland aquaculture is limited to raising the fish and to some extent fin fish (Crustaceans) production.

During the course of faunistic surveys it has been observed that there is regular sale of shellfish in several markets of eastern and north-eastern states. Shellfishes are harvested from the natural resources by different methods and brought to the market. There are no regular markets in some places but still people use the shellfish as food very frequently.

Arunachal Pradesh

Shellfishes are consumed throughout, although no regular marketing was observed during the visit. Three species (one gastropod and two bivalves) were used as food.

Meghalaya

Almost all the freshwater molluscs which occur abundantly are used as food. Shell fishes are more popular in the Garo hills than Khasi hills. Seven species, 6 gastropods and one bivalve are commonly used as food. These species are known under different names in Garo hills but a common term "Mattah" used for all molluscs in Khasi hills. Molluscs are regularly collected from the different water bodies for own consumption and also sold regularly in the market. These molluscs are sold in packets made out of fresh banana leaves or in lot.

Manipur

Shellfishes are regularly sold in different market of Manipur. Altogether 12 species 6 gastropods and 6 bivalves sold in the different markets of Manipur form the staple food for the local people. It was observed that about 250 to 300 kgs of shellfishes are sold daily in Imphal market, 100-150 kg at Churachandpur, Mairang, and Ukhrul. Gastropod shell with globose shape (like *Angulyara, Bellamya, Cipangopaludina,* and *Paludomus)*

Fig. 1. Shell fishes sold in the Imphal market.

are called "Thoroi" and the linear shape (like *Brotia)* called "Lai Thoraoi" The bivalves are called "Kongran" In the market a container of 1 liter tin gastropod shell cost Rs. 5/- to 7/- and the bivalves in heap containing 10-15 specimens cost Rs. 5/- to 6/-.

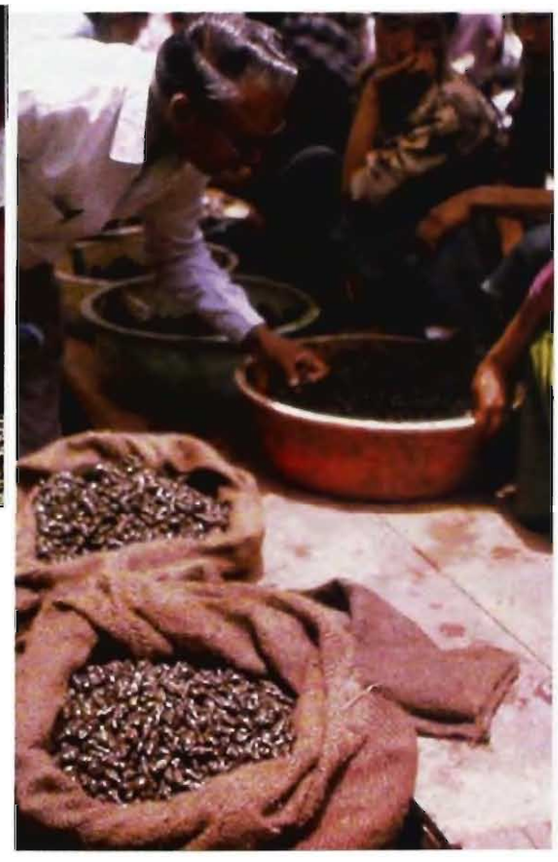


Fig. 2. Shell fishes sold in Churachandpur (Manipur) market.

Mizoram

Freshwater molluscs form a staple food for the people of Mizoram (Subba Rao and Dey, 1986). Almost all freshwater molluscs occuring abundantly are used as food. Local peoples the Mizo and Riang are very fond of shellfish. Fourteen species are consumed by the people either they collect them from natural stock or buy them from local market. Shellfishes are regularly sold in the Aizawl market (about 150-200 kgs/ daily) Champhai (50-60 Kgs/daily) and Vairangte (50-60 Kgs/daily).

Fig. 3. Shell fishes sold in Mizoram market.

West Bengal

Shellfishes are sold in the markets of the districts of Puruliya, Bankura (part), Midnapur (part), Darjeeling, Jalpaiguri, Kolkata, and Howrah. There is a regular market in Jhargram where more than 6 bags (about 250 kg) of *Bellamya* sp. sold at the rate of Rs. 5/- to 7/- per kg, *Pila* Rs. 4-5/- per kg and *Lamellidens* 8-10 per lot at the rate of Rs. 3/- to 5/- per lot. In Kolkata the shellfishes are sold in the different vegetable market (10 to 20 kg) every day. In Behala market the flesh of *Bellamya bengalensis* is extracted from the shell and sold at the rate of Rs. 40-50/- per kg, whereas with shell are sold at Rs. 10/- to 12/- per kg.

Fig. 4. Sale of shell fishes *Bellamya bengalensis* (Lamark) in Jhargram market, Paschim Midnapore, West Bengal.

Jharkhand

Although 22 species of freshwater molluscs occurs in the state of Jharkhand, only four species are favoured as food by the people. There is a regular sale of shellfishes in the different markets of Jharkhand. Most of these markets are weekly or biweekly and the price varies from market to market at the rate of Rs. 5/- to 8/- per kg for the snails. *Bellamya* sp. is favoured as food by all section of people, while *Pila* and *Lamellidens* spp. are eaten by tribal peoples only.

Shellfishes are eaten throughout the year. It depends mainly on the availability of shellfishes and the level of consumers, which varies from place to place. It is a very

Fig. 5. Removal of flesh from shell fishes after breaking the shell.

much favoured food item for the low-income group, but in Jharkhand *Bellamya* sp. is hold as prestigious item of food, by the people of all classes.

Shellfishes are collected from the natural sources by hand picking, trapping and by fishing nets. In Jharkhand the leaf trapping method is followed; palm leaves are placed in the littoral region of a pond or ditch in the evening. A number of *Bellamya* get attached to the leaf and next day these are taken out of the water and the snails are collected by hand picking.

Bihar

Freshwater shellfishes play an important role in the cottage industries in Mehsi town, East Champaran of Bihar. Shells of freshwater mussels used in the manufacture of shell buttons, ornaments and for the preparation of stalked lime. Shell grit, dust and residual pieces are used in the preparation of poultry feed and mosaic tiles (Baneerjee and Satish, 1988; Dutta Munshi and Chowdhury, 1988). According to them these industries require 700 tonnes of raw materials and market finished shell products of 120 lakhs annually. Such huge demand of raw materials had resulted in the over exploitation of local resources leading ultimately to depletion of population (Subba Rao, 1989). Non availability of raw materials had its impact on the industrial units decreasing the numbers of such units from 350 to 84 at present (Dutta Munshi and Chowdhury, 1988).

SOURCE OF PEARLS

In addition to their importance as supplementary food items of man, freshwater mussels produce the luxury item pearl, under natural conditions.

From the foregoing account it is clear that that freshwater shellfishes are important for food, as producers of pearl and raw materials of shell industry. For their sustainable utilisation of the species involved and their revival of shellfish's resources, it needs aquaculture.

Fig. 6. Freshwaters mussels *Lamellidens marginalis* (Lamark) with pearls.

Freshwater pearl

Pearl a precious item is produced by the mussels. Due to the irritation of presence of foreign bodies the mantle layers of the mussels secrets the shelly nacre around the foreign body, which becomes the pearl. The quality of pearl depends on the inner most nacreous layer of the molluscan shell known as mother of pearl. Although pearls of marine origin are very popular, but freshwater pearls are also gradually getting importance at present.

Pearl culture in freshwater mussels has been in practice in China and Japan (Mizumuto, 1976) in *Cristataria plicata* and *Hyriopsis schlegelai* respectively. The importance of water quality has been stressed in the farming (Mizumoto, 1976). It was found that the condition of water which favoured the good growth of pearl mussels may not produce the good quality of Pearl. From our observation it have been seen that aquatic bodies in West Bengal offer natural conditions for formation of pearls in the common freshwater mussels. So, far the natural occurrences of pearl has been recorded in *Lamellidens marginalis* from Burdwan, Bongaon, Dum Dum and Vidya Sagar colony, Ramgarh, Jadavpur. Pink coloured pearl, whose colour corresponded with the colour of the mother of pearl layer were found in *L. marginalis*. As per the

Fig. 7. Freshwater pearls taken out by cutting the common freshwater mussels, *Lamellidens marginalis* (Lamarck)

information mussels were around two years old. Pearls were recorded in the mussels having the shell size 82 x 40 mm and above. But it does mean that the shell with the higher measurements will yield the pearls. The price of the pond pearls fetch from Rs. 20/- to 100/- each depending on the size and quality. At present in and around Hyderabad area culture of freshwater pearls is practiced on commercial basis.

The pearl farming in freshwater mussels involves the following steps :

i) Preparation of host shell

ii) Nucleus insertion

iii) Convalescence

iv) Pearl formation

v) Nurturing procedure

i) Preparation of host shell : In nature pearls may be found in different region of the molluscan body. The best site of pearl formation is considered to be gonad. In pearl farming the nucleus is inserted to the gonodial region. From the experience it is inferred that spent individuals usually serve as good host. In the case of *Lamellidens* the suitable site and time are yet to be investigated.

ii) Nucleus insertion : It involves selection of suitable donor shell for obtaining nuclear material, and graft tissue for the freshwater mussels. The shell of *Parreysia* sp. which is thicker can be used for the formation of nuclei.

Graft tissue has to be obtained from the pallial zone of the living freshwater mussel. The operation on the living mussel has to be conducted very carefully so, that it should not cause any injury to the mussel. The graft tissue has to cover at least 1/3rd of the nucleus. The size of the nucleus determines the size of the piece of graft tissue.

After obtaining the nucleus and the graft tissue, the next step involves operation of the freshwater mussel and insertion of these into the gonodial region. The time and number of nuclei to be inserted have to be determined.

iii) Convalescence : After operation the mussel should be allowed to recover from the disturbance caused during operation. Then the freshwater mussel should be put back from where it was collected for the development of pearl. The cage culture method may not be suitable as the *Lamellidens* spp., are benthic forms.

iv) Pearl formation : The graft tissue on the nucleus grows into a pearl sac. The epithelial cells of the pearl sac deposit nacreous layer around the nucleus, ultimately leading to the formation of pearl.

Fig. 8. Removal of pearls from mussel, *Lamellidens marginalis* (Lamarck)

v) Nurturing method : In marine farming rafts of different kinds are used but nurturing techniques are yet be developed in the case of freshwater mussel.

From the above account it can be concluded that :

i) Molluscs plays important role not only in the coastal aquaculture but with proper techniques, it can also become an important component for freshwater aquaculture.

ii) Culture of few species of freshwater snails and mussels can be initiated. Culture of the following can be taken up :

a) Pila globosa (Swainson), *Bellamya bengalensis* (Lamarck) for food;

b) Lamellidens marginalis (Lamarck) and *L. corrianus* (Lea) for pearls.

iii) A stable and steady supply of seedling has to be maintained for which suitable breeding technique should be developed.

iv) The demand in domestic market is less for snails and mussels but these can be developed into valuable foreign exchange earner.

On the basis of above mentioned data it is clear that there is scope in our country to introduce and encourage culture of some more species of molluscs which are hitherto exploited from nature.

Fig. 9. Fresh water pearls taken out from *Lamellidens marginalis* (Lamarck) and sold in front of Mint, Taratola, Kolkata, West bengal.

Table-1. Freshwater molluscs used as food

Name of species	Common Name	States used as food
1. *Angulyagra oxytropis* (Benson)	Thoroi (Manipuri)	Manipur
2. *Bellamya bengalensis* (Lamarck)	Googli/Ghongi (Hindi, Kurmali), Chota Genda (Ho) Rookai/Ketla/Baska (Santhali), Googli/ Shamuk (Bengali), Genda Shamuk/Jal Ghanti (Oriya), Thoroi (Manipuri), Echalok (Garo), Mattah (Khasi), Sipuru/ Dhan Samuk (Baghmara), Chenkal (Mizo), Chikangbook, (Riang)	Arunachal Pradesh (Tirap), Bihar, Jharkhand, Manipur, Meghalaya Mizoram, Orissa, West Bengal
3. *Bellamya dissimilis* (Mueller)	Googli/Ghongi (Hindi, Kurmali), Chota Genda (Ho) Rookai/Ketla/Baska (Santhali), Googli/Shamuk (Bengali), Genda Shamuk/Jal Ghanti (Oriya), Echalok (Garo), Mattah (Khasi), Sipuru/Dhan Samuk (Baghmara)	Jharkhand, Bihar, Meghalaya, Orissa
4. *Cipangopaludina lecythis* (Benson)	Thoroi (Manipuri), Chenkal (Mizo), Chikangbook (Riang)	Manipur Mizoram
5. *Pila globosa* (Swainson)	Ghonga (Hindi, Kurmali, Mundari), Genda (Ho, Oriya), Marang rakai (Santhali), Shamuk (Bengali),	Bihar, Jharkhand, Orissa, West Bengal
6. *Pila theobaldi* (Hanley)	Yafu (Garo), Mattah (Khasi) Hamuk/Tomka Samuk (Baghmara)	Meghalaya
7. *Brotia (Antimelania) costula* (Rafinesque)	Mochra Samuk (Bengali), Lai Thoroi (Manipuri), Echalu (Garo), Mattah (Khasi), Sipuru rodong (Baghmara)	Arunachal Pradesh, Manipur, Meghalaya, West Bengal (North Bengal)

Name of species	Common Name	States used as food
8. *Paludomus blanfordiana* Nevill	Thoroi (Manipuri) Chenkal (Mizo) Chikangbook (Riang)	Arunachal Pradesh, Manipur, Mizoram
9. *Paludomus conica* (Gray)	Thoroi (Manipuri) Achhilu (Garo) Mattah (Khasi) Sipuru/Samuk (Baghmara) Chenkal (Mizo) Chikangbook (Riang)	Arunachal Pradesh, Manipur, Meghalaya, Mizoram
10. *Paludomus pustulosa* Annandale	Chenkal (Mizo) Chikangbook (Riang)	Mizoram
11. *Paludomus regulata* Benson	Echalok (Garo) Mattah (Khasi) Sipuru/Samuk (Baghmara) Chenkal (Mizo) Chikangbook (Riang)	Meghalaya, Mizoram
12. *Solenaia soleniformis* (Benson)	Tuikep (Mizo) Clampy (Beta)	Mizoram
*13. *Lamellidens corrianus* (Lea)	Chachni/Katla (Kurmali/ Mundari), Sunti (Ho) Jhinuk/Samuk (Oriya) Baska/Sunti (Santhali) Jhinuk/Katli (Bengali) Kongran (Manipuri)	Bihar, Jharkhand, Orissa, West Bengal, Manipur
14. *Lamellidens generosus* (Gould)	Kongran (Manipuri)	Manipur
*15. *Lamellidens marginalis* (Lamarck)	Chachni/Katla (Kurmali/ Mundari), Sunti (Ho) Jhinuk/Samuk (Oriya) Baska/Sunti (Santhali) Jhinuk/Katli (Bengali) Yafi (Garo), Mattah (Khasi) Jhinai (Baghmara)	Bihar, Jharkhand, Orissa, West Bengal, Meghalaya
16. *Lamellidens phenchooganjensis* (Benson)	Tuikep (Mizo), Clampy (Beta)	Mizoram
17. *Parreysia (Parreysia) burmanus* (Blanford)	Kongran (Manipuri)	Manipur

Name of species	Common Name	States used as food
18. *Parreysia (Parreysia) flavidens* (Benson)	Chachni/Katla (Kurmali/ Mundari), Sunti (Ho), Jhinuk/Samuk (Oriya) Baska/Sunti (Santhali) Jhinuk/Katli (Bengali) Kongran (Manipuri) Tuikep (Mizo), Clampy (Beti)	Bihar, Jharkhand, Orissa, West Bengal, Manipur, Mizoram
19. *Parreysia (Parreysia) sikkimensis* (Lea)	Kongran (Manipuri), Tuikep (Mizo) Clampy (Beti)	Manipur, Mizoram
20. *Parreysia (Radiatula) caerulea* (Lea)	Chachni/Katla (Kurmali/ Mundari), Sunti (Ho), Jhinuk/Samuk (Oriya), Baska/Sunti (Santhali), Jhinuk/Katli (Bengali), Tuikep (Mizo), Clampy (Beti)	Bihar, Jharkhand, Orissa, West Bengal, Mizoram
21. *Parreysia (Radiatula) occata* (Lea)	Kongran (Manipuri)	Manipur
22. *Trapezoideus exolescens exolescens* (Gould)	Kongran (Manipuri), Tuikep (Mizo), Clampy (Beti)	Manipur, Mizoram

* Species produce pearls.

FRESHWATER SNAILS AND DISEASES

Schistosomiasis is a disease of various mammals including men and domestic livestock caused by the blood flukes, well known trematodes of the genera *Schistosoma, Orienthobilharzia* and *Bivitellobitharzia.* These blood flukes inhabitat the hepatic portal system and pelvic veins of birds and mammals, including man. Eggs laid by the parasite pass through the wall of the intestine or bladder and are voided with the faeces or urine of the host. If the eggs fall into water they hatch, producing a ciliated larva (miracidium) which to continue its development must locate and penetrate a suitable snail within a few hours. In India the snails (intermediate) host belong to families Planorbidae, Lymnaeidae and Ancylidae of genera *Indoplanorbis, Lymnaea* and *Ferrisia.*

In India human schistosomiasis was reported in as early as 1878. Later reports included urinary schistosomiasis from Mumbai. Eggs of *Schistosoma haematobium* and *S. bovis* were detected from Chennai. Sporadic reports of urinary schistosomiasis came from different parts of the country *i.e.* Rajkot, Chennai, Goa and Kolkata.

After the world war (1914-18) it was feared that Indian Troops returning from Egypt, East Africa and other endemic areas carries the infection to India. African Troops stationed in different part of the country spread the infection. A case of haematuria due to *Schistosoma haematobium* infection was reported from Gimvi village, Ratnagiri district of Maharashtra. Efforts were made to find out the vector snail. First *Paludomus obesa* was incriminated but later *Ferrisia tenuis* was detected as the vector snail (Gadgil and Shah 1955). Other endemic focii were located in Tirupparankumdaram, Madurai distinct of Tamil Nadu (Sundarajulu, 1967) and Lohager in Raipur district, Chhatrishgarh (Srivastava and Arora, 1969). These cases need confirmation.

Table 2. Schistosomes with their hosts and distribution from India.

Species	Host	Distribution	Intermediate host	Reported by
1. *Schistosoma haematobium* (Bilharz)	Man, Monkey and Artiodactyls	Ratnagiri, Maharashtra	*Ferrisia tenuis*	Gadgil and Shah (1955), Shah and Gadgil (1955)
2. *Schistosoma indicum* Montgomery	Horse, Donkey, Camel, Sheep, Goat, Cattle, Buffaloes, Zebra, Antelope	India (throughout)	*Indoplanorbis exustus*	Dutt and Srivastava (1962)
3. *Schistosoma incognitum* Chandler	Dog, Pig, Cat, Sheep, Goat, Rabbit, Guinea pig, rat.	Uttar Pradesh, Tamil Nadu, Bihar, West Bengal, Jharkhand	*Lymnaea luteola* f. *australis* f. *succinea* f. *ovalis*	Sinha and Srivastava (1954, 1956, 1960)
4. *Schistosoma spindale* Montgomery	Buffaloes, Bandicoot, Cattle, Goat, Guinea pig	India	*Indoplanorbis exustus, Lymnaea acuminata, Lymnaea luteola*	Montgomery (1906), Malkani (1932)
5. *Schistosoma nasale* Rao	Cattle, Buffalo, Goat	India	*Lymnaea luteola, Indoplanorbis exustus,*	Dutta and Srivastava (1968) Sengupta and Sinha (1966)
6. *Orientobitharzia bomfordi* (Montgomery)	Cattle, Buffalo	Mukteswar (Gujarat)	Not Known	Dutta and Srivastava (1956)

Species	Host	Distribution	Intermediate host	Reported by
7. *Orientobitharzia dattai* (Dutta & Srivastava)	Buffalo, Rabbit, Guinea pig, Mouse.	Bareilly (U.P)	*Lymnea luteola*	Dutta and Srivastava (1952, 1955, 1961, 1962)
8. *Orientobitharzia turkestanicum* (Skrjabin)	Cattle, Buffalo, Goat, Horse, Donkey, Mule, Camel.	Kashmir	*Lymnaea auricularia* *Lymnaea acuminata rufescens*	Dutta and Srivastava (1955, 1964), Srivastava and Trisul (1957)
9. *Bivitellobitharzia nairi* (Mudaliar and Ramanujachari)	Elephant	Coimbatore (Tamil Nadu)	Not Known	Mudaliar and Ramanujachari (1945), Dutt and Srivastava (1955)

The animal schistosomiasis in India was reported by Bomford (1886, 1887) presence of *Schistosoma haematobium* eggs in large intestine of two bullocks of Kolkata. Later Montgomery (1906) described *Schistosoma bomfordi* and *S. spindalis* from the portal veins of cattle; *S. indicum* from horse and *S. bovis* from sheep. The occurrence of *S. bovis* was doubted. Malkoni (1932) reported nasal schistosomiasis in which cauliflower like growth developed on the nasal septum of cattle caused by *S. nasalis*. Chandler (1926) described *S. incognitium* and Swaminathan (1934) reported the same from dog from Jabalpur. Mudaliar and Ramanujachari (1945) described *S. nairi* from the liver of an elephant from Coimbatore, Tamil Nadu which belongs to Genus *Orientobitharzia*. Later on. Dutt and Srivastava (1952) described *Orientobitharzia dattai* from sheep and goat. Srivastava and Trisul (1957) recorded *S. turkestanicum* from cattle of Kashmir. Dutt and Sivastava (1968) studied the life cycle and pathogenicity of *S. nasale* from cattle and buffalo. This parasite was reported from goat from West Bengal by Sengupta and Sinha (1966). The intermediate host for all these parasite are *Indoplanorbis exustus* (Deshayes), *Lymnaea luteola* Lamarck, *Lymnaea acuminata* Lamarck, *Lymnaea auricularia* (Linnaeus) and *Ferrisia tenuis* (Bourguignat).

PARAGONIMIASIS

The lung fluke, *Paragonimus* causes Paragonimiasis with suggestive symptoms of tuberculosis in man and animals.This parasites also been recorded from brain, spinal cord and other organs of man, cat, dog, fox, pig, goat, cattle etc. This fluke associates with Jackson epilepsy, eosinophilic meningitis and some other nervous diseases.

Paragonimus spp. are recorded from bronchi, lung and occasionally in liver and spleen of man, tiger, wolf, pig, dog, cat, mongoose etc. from various parts of India.

The snail host of *Paragonimus* spp. mainly belong to family Thiaridae and the species are *Tarebia granifera* (Lamarck) and *Melanoides tuberculata* (Mueller).

Table 3. Paragonimiasis with their host and distribution in India

Species	Host	Distribution	Recorded by
Paragonimus compactus	Mangoose (*Herpestes edwardsi*)	India	Veevers (1923)
Paragonimus westermani	Man, Lungs of tiger, Dog, Pig, Wolf, Mongoose	Malabar Coimbatore, Panthnagar, Visakhapatnam	Rao(1935), Srivastava (1935) Ravikumar *et al.* (1979)
Paragonimus edwardsi	Lung of Palm civet *Paradoxurus grayi*	Kumaun hills	Gulati (1926)

AMPHISTOMIASIS

Amphistomiasis is caused by trematode parasites *Amphistomes* infecting both cold and warm blooded animals including man. Mukherjee and Chauhan (1965) and Dutt (1980) have listed 23 and 20 species of amphistomes respectively from domesticated ruminants of India. The pathogenic amphistomes belong to three genera *viz. Paramphistomum, Cotylophoron* and *Gastrothylax.* In India *Gastrodiscoides huminis* is the only species found in man and pig, highly pathogenic to man.

The vector snails for this species are *Bithynia (Digoniostoma) pulchella* (Benson), *Lymnaea auricularia* (Linnaeus), *Lymnaea (Pseudosuccinea) luteola* Lamarck, *Gyraulus convexiusculus* (Hutton) and *Indoplanorbis exustus* (Deshayes).

LIST OF THE FRESH WATER MOLLUSCAN SPECIES IN INDIA

Class GASTROPODA
Subclass PROSOBRANCHIA
Order ARCHAEOGASTROPODA
Superfamily NERITOIDEA
Family NERITIDAE
Subfamily NERITINAE
Genus ***Neritina*** Lamarck, 1816
Subgenus ***Neritina*** *s. st.*

1. *Neritina (Neritina) pulligera* (Linnaeus)

Subgenus ***Dostia*** Gray, 1847

2. *Neritina (Dostia) platyconcha* (Annandale and Prashad)
3. *Neritina (Dostia) violacea* (Gmelin)

Subgenus ***Neripteron*** Lesson, 1830

4. *Neritina (Neripteron) auriculata* Lamarck

Subgenus ***Vittina*** H.B. Baker, 1923

5. *Neritina (Vittina) perottetiana* (Recluz)
6. *Neritina (Vittina) smithi* Wood
7. *Neritina (Vittina) turrita* (Gmelin)
8. *Neritina (Vittina) variegata* Lesson

Genus ***Neritodryas*** von Martens, 1869

9. *Neritodryas subsulcata* (Sowerby)

Genus ***Theodoxus*** Montfort, 1810
Subgenus ***Clithon*** Montfort, 1810

10. *Theodoxus (Clithon) bicolor* (Recluz)
11. *Theodoxus (Clithon) corona* (Linnaeus)
12. *Theodoxus (Clithon) reticularis* (Sowerby)

Family SEPTARIIDAE
Genus ***Septaria*** Ferrussac, 1807

13. *Septaria lineata* (Lamarck)

14. *Septaria porcellana* (Linnaeus)

Order MESOGASTROPODA
Superfamily VIVIPAROIDEA
Family VIVIPARIDAE
Subfamily VIVIPARINAE
Genus ***Taia*** Annandale, 1918

15. *Taia crassicallosa* Annandale and Rao

Subfamily BELLAMYINAE
Genus ***Bellamya*** Jousseaume, 1886

16. *Bellamya bengalensis* (Lamarck)
form *typica* (Lamarck)
form *annandalei* (Kobelt)
form *balteata* (Benson)
form *colairensis* (Annandale)
form *doliaris* (Gould)
form *eburnea* (Annandale)
form *gigantea* (Reeve)
phase *halophila* (Kobelt)
form *mandiensis* (Kobelt)

17 *Bellamya crassispiralis* (Annandale)
18. *Bellamya crassa* (Benson)
19. *Bellamya dissimilis* (Mueller)
20. *Bellamya micron* (Annandale)

Genus ***Angulyagra*** Rao, 1931

21. *Angulyagra microchaetophora* (Annandale)
22. *Angulyagra oxytropis* (Benson)

Genus ***Cipangopaludina*** Hannibal, 1912

23. *Cipangopaludina lecythis* (Benson)

Family AMPULLARIIDAE
Genus ***Pila*** (Bolten) Roeding, 1798

24. *Pila globosa* (Swainson)

var *incrassatula* (Nevill)
var *minor* (Nevill)

25. *Pila scutata* (Mousson)
var *compacta* Reeve
26. *Pila theobaldi* (Hanley)
27 *Pila virens* (Lamarck)

Subgenus ***Turbinicola*** Annandale and Prashad, 1921

28. *Pila (Turbinicola) saxea* (Reeve)

Superfamily VALVATOIDEA
Family VALVATIDAE
Genus ***Valvata*** Mueller, 1774

29. *Valvata piscinalis* (Mueller)

Superfamily LITTORINOIDEA
Family LITTORINIDAE
Subfamily LITTORININAE
Genus ***Mainwaringia*** Nevill, 1884

30. *Mainwaringia paludomoidea* Nevill

Subfamily BEMBICIINAE
Genus ***Cremnoconchus*** Blanford, 1869

31. *Cremnoconchus syhadrensis* (Blanford)

Subgenus ***Lissoconchus*** Thiele, 1931

32. *Cremnoconchus (Lissoconchus) carinatus* (Layard)
33. *Cremnoconchus (Lissoconchus) conicus* (Blanford)

Superfamily RISSOIDEA
Family HYDROBIIDAE
Subfamily POTAMOPYRGINAE
Genus ***Potamopyrgus*** Stimpson, 1865
Subgenus ***Indopyrgus*** Thiele, 1928

34. *Potamopyrgus (Indopyrgus) nevilli* Thiele

Family BITHYNIIDAE

Genus ***Bithynia*** Leach, 1818

35. *Bithynia tentaculata kashmirensis* (Nevill)
36. *Bithynia troscheli* (Paasch)

Subgenus ***Digoniostoma*** Annandale, 1920

37 *Bithynia (Digoniostoma) cerameopoma* (Benson)
38. *Bithynia (Digoniostoma) evezardi* (Blanford)
39. *Bithynia (Digoniostoma) pulchella* (Benson)
40. *Bithynia (Digoniostoma) textum* Annandale

Genus ***Gabbia*** Tryon, 1865

41. *Gabbia orcula* Frauenfeld
    var. *producta* (Nevill)
42. *Gabbia stenothyroides* (Dohrn)
43. *Gabbia travancorica* (Benson)

Genus ***Mysorella*** Annandale, 1919

44. *Mysorella costigera* (Kuester)

Family POMATIOPSIDAE

Subfamily TRICULINAE

Tribe **Triculini**

Genus ***Tricula*** Benson, 1843

45. *Tricula gravelyi* Prashad
46. *Tricula montana* Benson

Family STENOTHYRIDAE

Genus ***Stenothyra*** Benson, 1856

47 *Stenothyra blanfordiana* Nevill
48. *Stenothyra deltae* (Benson)
49. *Stenothyra foveolata* Benson
50. *Stenothyra hungerfordiana* Nevill
51. *Stenothyra minima* (Sowerby)
52. *Stenothyra nana* Prashad
53. *Stenothyra ornata* Annandale and Prashad
54. *Stenothyra soluta* Annandale and Prashad

55. *Stenothyra woodmasoniana* Nevill

Genus ***Gangetia*** Ancey, 1890

56. *Gangetia miliacea* (Nevill)

Family IRAVADIIDAE

Genus ***Iravadia*** Blanford, 1867

57 *Iravadia annandalei* Preston
58. *Iravadia ennurensis* Preston
59. *Iravadia funerea* Preston
60. *Iravadia princeps* Preston

Family ASSIMINEIDAE

Subfamily ASSIMINEINAE

Genus ***Assiminea*** Fleming, 1828

61. *Assiminea francessi* (Wood)

Supefamily CERITHIOIDEA

Family THIARIDAE

Subfamily THIARINAE

Genus ***Thiara*** Roeding, 1798

Subgenus ***Thiara*** s. st.

62. *Thiara (Thiara) amarula* (Linnaeus)
63. *Thiara (Thiara) rudis* (Lea)
64. *Thiara (Thiara) scabra* (Mueller)

Subgenus ***Sermyla*** H. and A. Adams, 1854

65. *Thiara (Sermyla) riqueti* (Grateloup)

Genus ***Faunus*** Montfort, 1810

66. *Faunus ater* (Linnaeus)

Genus ***Melanoides*** Olivier, 1804

67 *Melanoides crebra* Lea
68. *Melanoides nevillei* (Brot)
69. *Melanoides nicobarica* (Reeve)
70. *Melanoides peddamunigalensis* Ray and Roy Chowdhury
71. *Melanoides tuberculata* (Mueller)

Genus ***Stenomelania*** P.Fischer, 1885

72. *Stenomelania aspirans* (Hinds)
73. *Stenomelania plicaria* (Born)
74. *Stenomelania punctata* (Lamarck)
75. *Stenomelania torulosa* (Bruguiere)

Genus ***Tarebia*** H. and A.Adams, 1854

76. *Tarebia granifera* (Lamarck)
77 *Tarebia lineata* (Gray)
78. *Tarebia semigranosa* von dem Busch

Family PLEUROCERIDAE
Subfamily MELANATRIINAE
Genus ***Brotia*** H. Adams, 1866
Subgenus ***Brotia*** s.st.

79. *Brotia (Brotia) fuscata* (Born)

Subgenus ***Antimelania*** Fischer and Crosse, 1892

80. *Brotia (Antimelania) costula* (Rafinesque)

Genus ***Sulcospira*** Troschel, 1858

81. *Sulcospira huegeli* (Philippi)

Subfamily PALUDOMINAE
Genus ***Paludomus*** Swainson, 1840
Subgenus ***Paludomus*** s.st.

82. *Paludomus(Paludomus) annandalei* Preston
83. *Paludomus(Paludomus) blanfordiana* Nevill
84. *Paludomus(Paludomus) conica* (Gray)
    var. *kopiliensis* Nevill
85. *Paludomus(Paludomus) inflatus* Brot
86. *Paludomus(Paludomus) obesus* (Philippi)
87. *Paludomus(Paludomus) ornatus* Benson
88. *Paludomus(Paludomus) pustulosa* Annandale
89. *Paludomus(Paludomus) regulata* Benson
90. *Paludomus(Paludomus) reticulata* Blanford

91. *Paludomus(Paludomus) rotunda* Blanford
92. *Paludomus(Paludomus) stephanus* (Benson)
93. *Paludomus(Paludomus) transchauricus* (Gmelin)

Subgenus ***Philopotamis*** Layard, 1855

94. *Paludomus (Philopotamis) sulcatus* Reeve

Subgenus ***Stomatodon*** Benson, 1862

95. *Paludomus (Stomatodon) stomatodon* Benson

Subgenus ***Tanalia*** Gray, 1847

96. *Paludomus (Tanalia) loricatus* Reeve
97 *Paludomus (Tanalia) neritoides* Reeve

Subclass PULMONATA
Order BASOMMATOPHORA
Superfamily LYMNOIDEA
Family LYMNAEIDAE
Genus ***Lymnaea*** Lamarck, 1799
Subgenus ***Lymnaea*** *s. st.*

98. *Lymnaea stagnalis* (Linnaeus)

Subgenus ***Pseudosuccinea*** F. C. Baker, 1908

99. *Lymnaea (Pseudosuccinea) acuminata* Lamarck
    form *typica* Lamarck
    form *brevissima*Annandale and Rao
    form *chlamys* Benson
    form *gracilior* Martens
    form *hians* Sowerby
    form *malleata* Annandale and Rao
    form *patula* Troschel
    form *rufescens* Gray
100. *Lymnaea (Pseudosuccinea) biacuminata* Annandale and Rao
101. *Lymnaea (Pseudosuccinea) horae* Annandale and Rao
102. *Lymnaea (Pseudosuccinea) luteola* Lamarck
    form *typica* Lamarck

form *australis* Annandale and Rao
form *impura* Troschel
form *ovalis* Gray
form *succinea* Deshayes

103. *Lymnaea (Pseudosuccinea) ovalior* Annandale and Prashad

Genus ***Galba*** Schrank, 1803

104. *Galba andersoniana* (Nevill)
105. *Galba hookeri* (Reeve)
106. *Galba truncatula* (Mueller)

Genus ***Radix*** Montfort, 1810

107. *Radix auricularia* (Linnaeus)
108. *Radix brevicauda* (Sowerby)
109. *Radix lagotis* form *costulata* (von Martens)
form *defilippi* (Issel)
form *solidissima* (Kobelt)
form *striata* (Andreae)
110. *Radix persica* (Issel)

Genus ***Stagnicola*** Leach in Jeffreys, 1830

111. *Stagnicola tungabhadraensis* (Ray)

Superfamily PHYSOIDEA
Family PHYSIDAE
Genus ***Physa*** Draparnaud, 1801

112. *Physa acuta* Draparnaud

Superfamily PLANORBIOIDEA
Family PLANORBIDAE
Subfamily PLANORBINAE
Tribe **Planorbeae**
Genus ***Planorbis*** Mueller, 1774

113. *Planorbis planorbis tangitarensis* Germain
114. *Planorbis rotundatus* Poiret

Genus ***Gyraulus*** Agassiz in Charpentier, 1837

115. *Gyraulus barrackporensis* (Clessin)

116. *Gyraulus convexiusculus* (Hutton)
117. *Gyraulus euphraticus* (Mousson)
118. *Gyraulus labiatus* (Benson)
119. *Gyraulus ladacensis* Nevill
120. *Gyraulus pankongensis* (von Martens)
121. *Gyraulus rotula* (Benson)
122. *Gyraulus saltensis* Germain

Tribe **Camptocerateae**

Genus ***Camptoceros*** Benson, 1843

123. *Camptoceras lineatum* Blanford
124. *Camptoceras subspinosum* Annandale and Prashad
125. *Camptoceras terebra* Benson

Tribe **Segmentinineae**

Genus ***Segmentina*** Fleming, 1822

Subgenus ***Polypylis*** Pilsbry, 1906

126. *Segmentina (Polypylis) calatha* (Benson)
127. *Segmentina (Polypylis) taia* Annandale & Rao
128. *Segmentina (Polypylis) trochoidea* (Benson)

Genus ***Hippeutis*** Agassiz in Charpentier, 1837

129. *Hippeutis fontanus* (Lightfoot)

Subgenus ***Helicorbis*** Benson, 1855

130. *Hippeutis (Helicorbis) umbilicalis umbilicalis* (Benson)

Family BULLINIDAE

Subfamily BULLININAE

Genus ***Indoplanorbis*** Annandale and Prashad, 1920

131. *Indoplanorbis exustus* (Deshayes)

Family ANCYLIDAE

Subfamily FERRISSINAE

Genus ***Ferrissia*** Walker, 1903

132. *Ferrissia baconi* (Bourguignat)
133. *Ferrissia ceylanica* (Benson)

134. *Ferrissia tenuis* (Bourguignat)
135. *Ferrissia verruca* (Benson)
136. *Ferrissia viola* Annandale and Prashad

Class BIVALVIA
Subclass PTERIOMORPHIA
Order ARCOIDA
Superfamily ARCOIDEA
Family ARCIDAE
Subfamily ANADARINAE
Genus ***Scaphula*** Benson, 1834

137. *Scaphula celox* Benson
138. *Scaphula deltae* Blanford
139. *Scaphula nagarjunai* Janaki Ram and Radhakrishna

Subclass PALEOHETERODONTA
Order UNIONOIDA
Superfamily UNIONOIDEA
Family UNIONIDAE
Subfamily UNIONINAE
Genus ***Arcidopsis*** Simpson, 1900

140. *Arcidopsis footei* (Theobald)

Genus ***Physunio*** Simpson, 1900
Subgenus ***Velunio*** Haas, 1914

141. *Physunio (Velunio) velaris* (Sowerby)

Genus ***Scabies*** Haas, 1911

142. *Scabies crispata* (Gould)

Genus ***Solenaia*** Conard, 1868

143. *Solenaia soleniformis* (Benson)

Subfamily AMBLEMINAE (Quadrulinae)
Tribe **Amblemini**
Genus ***Lamellidens*** Simpson, 1900

144. *Lamellidens consobrinus* (Lea)

145. *Lamellidens corrianus* (Lea)
146. *Lamellidens generosus* (Gould)
147. *Lamellidens jenkinsianus* (Benson)
 sub sp. *daccaensis* (Preston)
 sub sp. *obesa* (Hanley and Theobald)
148. *Lamellidens marginalis* (Lamarck)
149. *Lamellidens phenchooganjensis* Preston

Genus ***Parreysia*** Conrad, 1853

Subgenus ***Parreysia*** s.st.

150. *Parreysia (Parreysia) annandalei* Preston
151. *Parreysia (Parreysia) burmanus* (Blanford)
152. *Parreysia (Parreysia) corbis* (Benson)
153. *Parreysia (Parreysia) corrugata* (Mueller)
 subsp. *laevirostris* (Benson)
 subsp. *nagpoorensis* (Lea)
154. *Parreysia (Parreysia) favidens* (Benson)
 var *assamensis* Preston
 var *chrysis* (Benson)
 var *deltae* (Benson)
 var *marcens* (Benson)
 var *plagiosoma* (Benson)
 var *viridula* (Benson)
155. *Parreysia (Parreysia) gowhattensis* (Theobald)
156. *Parreysia (Parreysia) rajahensis* (Lea)
157. *Parreysia (Parreysia) sikkimensis* (Lea)
158. *Parreysia (Parreysia) smaragdites* (Benson)
159. *Parreysia (Parreysia) triembolus* (Benson)

Subgenus ***Radiatula*** Simpson, 1900

160. *Parreysia (Radiatula) andersoniana* (Nevill)
161. *Parreysia (Radiatula) bonneaudi* (Eydoux)
162. *Parreysia (Radiatula) caerulea* (Lea)
 subsp. *gaudichaudi* (Eydoux)
163. *Parreysia(Radiatula) cylindrica* Annandale and Prashad
164. *Parreysia (Radiatula) involuta* (Benson)
165. *Parreysia (Radiatula) khadakvaslaensis* (Ray)

166. *Parreysia (Radiatula) lima* (Simpson)
167. *Parreysia (Radiatula) nuttalliana* (Lea)
168. *Parreysia (Radiatula) occata* (Lea)
169. *Parreysia (Radiatula) olivaria* (Lea)
170. *Parreysia (Radiatula) pachysoma* (Benson)
171. *Parreysia (Radiatula) shurtleffiana* (Lea)
172. *Parreysia (Radiatula) theobaldi* (Preston)

Genus ***Trapezoideus*** Simpson, 1900

173. *Trapezoideus exolescens exolescens* (Gould)

Superfamily MUTELOIDEA
Family ETHERIIDAE
Genus ***Pseudomulleria*** Anthony, 1907

174. *Pseudomulleria dalyi* (E.A. Smith)

Subclass HETERODONTA
Order VENEROIDA
Superfamily SOLENOIDEA
Family CULTELLIDAE
Genus ***Neosolen*** Ghosh, 1920

175. *Neosolen aquaedulcioris* Ghosh

Genus ***Tanysiphon*** Benson, 1858

176. *Tanysiphon rivalis* Benson

Superfamily TELLINOIDEA
Family PSAMMOBIIDAE
Subfamily NOVACULININAE
Genus ***Novaculina*** Benson, 1830

177. *Novaculina gangetica* Benson

Superfamily CORBICULOIDEA
Family CORBICULIDAE
Genus ***Corbicula*** Megerle, 1811

178. *Corbicula annandalei* Prashad
179. *Corbicula assamensis* Prashad
180. *Corbicula bensoni* Deshayes

181. *Corbicula cashmiriensis* Deshayes
182. *Corbicula krishnaea* Ray
183. *Corbicula peninsularis* Prashad
184. *Corbicula striatella* Deshayes

Genus ***Batissa*** Gray, 1853

185. *Batissa inflata* Prime
186. *Batissa similis* Prime

Genus ***Polymesoda*** Rafinesque, 1820
Subgenus ***Geloina*** Gray, 1842

187. *Polymesoda (Geloina) bengalensis* (Lamarck)
188. *Polymesoda (Geloina) erosa* (Solander)

Genus ***Villorita*** Gray in Griffith and Pidgeon, 1834

189. *Villorita cornucopia* Prashad

Family PISIDIIDAE (Sphaeriidae)
Genus ***Pisidium*** L. Pfeiffer, 1821
Subgenus ***Pisidium*** s.st.

190. *Pisidium (Pisidium) casertanum* (Poli)

Subgenus ***Afropisidium*** Kuiper, 1962

191. *Pisidium (Afropisidium) clarkeanum* G. and H. Nevill
192. *Pisidium (Afropisidium) ellisi* Dance
193. *Pisidium (Afropisidium) nevillianum* Theobald

Subgenus ***Europisidium*** Stadnichenko, 1984

194. *Pisidium (Europisidium) mitchelli* Prashad

Subgenus ***Odhnerpisidium*** Kuiper, 1982

195. *Pisidium (Odhnerpisidium) atkinsonianum* Theobald
196. *Pisidium (Odhnerpisidium) kuiperi* Dance

Genus ***Sphaerium*** Scopoli, 1777

197. *Sphaerium austeni* Prashad
198. *Sphaerium indicum* Deshayes
199. *Sphaerium kashmirensis* Prashad

GASTROPODS

Shell

The shell of a gastropod is a single, dextrally coiled spiral valve. Sinistral shell occurs among the freshwater Indian forms in the genus *Camptoceros*. Shell encloses the visceral mass and the foot when the animal retracts. Shell varies in shape and size. Normally a shell is an elongated cone wound into a spiral around a central axis, columella. The turns of the spiral are known as whorls and are demarcated by lines called sutures. These may be simple smooth lines or wavy, irregular or more or less indented. The largest whorl called the body whorl, bounds by large opening known as the aperture, through which the foot and anterior part of the snail body can be protruded or retracted. During locomotion the snail carries the shell with the aperture forward, due to which the aperture is anterior and the apex considered as posterior. The edge of aperture is called as outer lip and its opposite wall the inner lip is continuous with the columella. The body whorl and the aperture are drawn out anteriorly into a spout of variable length known as siphonal canal which houses the siphon. A similar but small canal is also present at posterior or upper end of aperture. The smaller whorls decreasing in size to a pointed apex that forms spire. Adjacent to aperture in the axis of the shell there is a hole, the umbilicus.

When a gastropod shell is held with the aperture facing the observers apex upwards; if the aperture is at right hand then the shell is known as dextral and if it is on left hand then the shell is known as sinistral.

Sculpture sometimes smooth, but usually with ridges, grooves, ribs, tubercles or various sorts of projections may with parallel to suture or run right angled to them.

The shell consists of an outer thin organic layer called periostracum and three calcareous layers. The outer layer prismatic; middle layer of lamellae and inner layer nacreous, known as hypostracum, composed of calcareous lamellae interleaved with the organic layer.

Periostracum is thin, often brown layer composed of organic material some form of sclerotized protein, the conchiolin. It may easily be eroded or broken off. The prismatic and lamellae layers made up of calcium carbonate either of calcite or as aragonite. Aragonitic layers are lamellate; consist of rectangular plates like the leaves of a book, composed of calcareous fibrils.

The shell of freshwater gastropods offers a great number of characters important for taxonomy. The general shape, presence or absence of operculum, the number, nature of coiling, shape of whorls, sculpture, the nature of umbilicus and columella and the shape and size of the aperture of shell are very important to taxonomists.

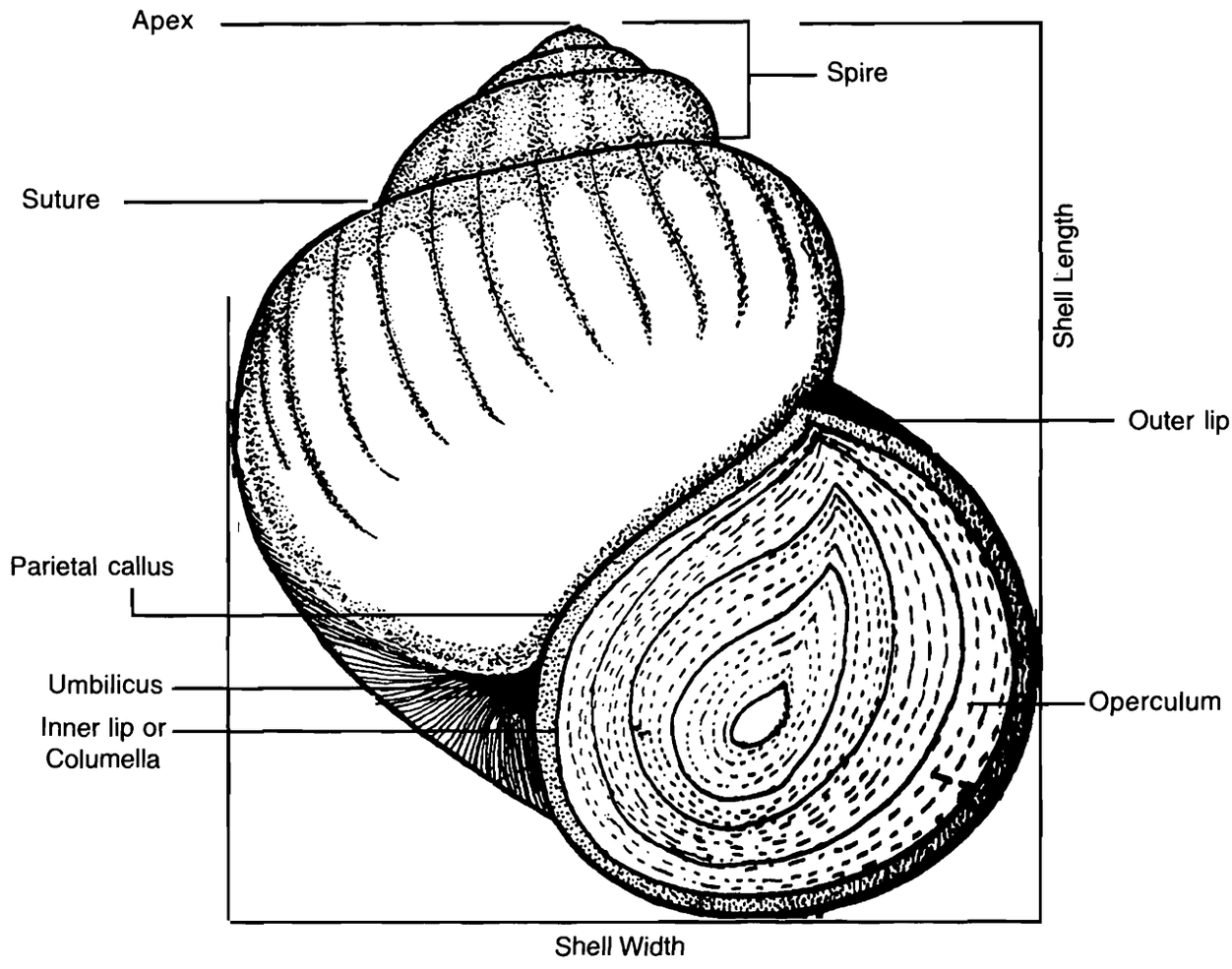


Fig. 10. Diagramatic Sketch of typical gashopod shell showing the shell terminology

In Indian freshwater gastropods broadly six different shapes of shell are recorded :

1. Ovate or globose with large body whorl and aperture, spire with 2-3 whorls, found in large number of gastropods.
2. Cup shape or limpet shape shell with faint traces of coiling occurs in the family Ancylidae and Septariidae.
3. Turreted shell with several whorls characteristics of the family Thiaridae.
4. Discoidal or planispiral shell, where all whorls are in some plane and coil like watch spring found in family Planorbidae.
5. Sinistral shell found in Genus *Camptoceras.*
6. Dextral and ovately-oblong shell found in family Lymnaeidae.

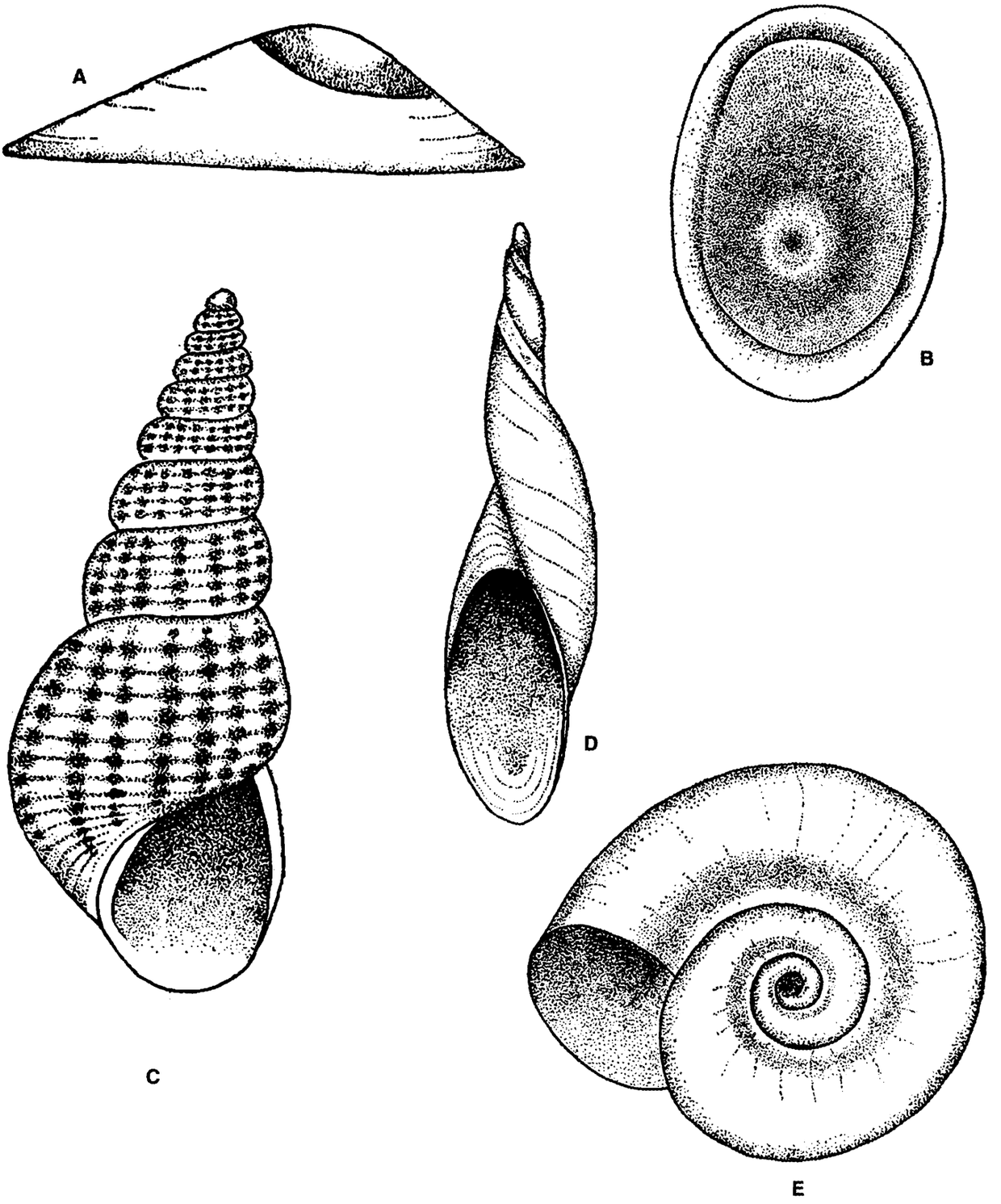


Fig. 11. Showing different types of shell. **A–B** Limpet Shape; **C** Turreted; **D** Sinstral Shell; **E** Discoidal Shell

Central body

The snail body is permanently fastened with the shell. It consists of head, foot, mantle and visceral mass. In general the gastropod posses a bilaterally symmetrical head with tentacles, eyes and a terminal mouth. The ventral part of the body has a muscular foot with flat creeping sole and bearing dorsally on posterior end the operculum, which serves to close the aperture. The entire foot and anterior part of the body are protrusible from the shell. The mantle is a collar like fold of the body wall that lives the body whorl leaving a space the mantle or pallial cavity. The mantle may be drawn out into siphons that occupy the siphonal canal function in respiration. The mantle cavity houses a number of structures collectively known as pallial complex. The pallial complex comprises the gill (ctenidium), osphridium, hypobranchial gland, anus, rectum, nephridiopore or gonopore. The mantle and pallial complex are located anteriorly in the prosobranchs but in opisthobranchs shifted along the right side to a more or less posterior position. In pulmonates the mantle cavity is reduced to a small respiratory sac with highly vascular walls and the organs of pallial complex are either lost or located outside the pulmonary sac.

Head and foot can protrusible through the aperture the but rest of the body (visceral mass) is permanently contained in larger turns of the spire and is often spirally coiled. It contains the greater part of digestive tract, including the liner (midgut gland), the heart, nephridium and the reproductive system.

The digestive tract comprises of a muscular pharynx; a pair of jaws; one or two pairs of salivary gland; a long oesophagus; stomach which receives the ducts from large midgut gland (liner); intestine (typically wind back) and the hindgut or rectum which pass through the pericardial cavity. The radula is wanting in some snails the pneumatic forms present into the floor of pharynx. It consists of a basal membrane composed of chitin, bearing teeth. The number of teeth varies from a few to many thousands. The shape and pattern of these teeth are taxonomically important.

Respiration of gastropods mainly carried out by gills known as ctenidium.The ctenidium consists of a longitudinal series of three leaves borne on a central axis. They may be bipectinate or monopectinate. In most of pulmonate the gill is wanting. The free edge of the mantle cavity is altered into vascularised pulmonary sac for respiration.

The osphridium, a chemoreceptor organ developed as miniature gill is located on the mantle roof adjacent to the ctenidium.

The heart present in the pericardial cavity is composed of one ventricle and two auricles. The gastropods have a pair of symmetric gills have two auricles in heart and the gastropods which have one gill have one auricle in heart. The circulation is very open and is completed through body sinuses and lacunae. Before returning to the heart, the blood posses through gills and the nephridia. The respiratory pigment of the blood is haemocynin but haemoglobin also occurs in some gastropods.

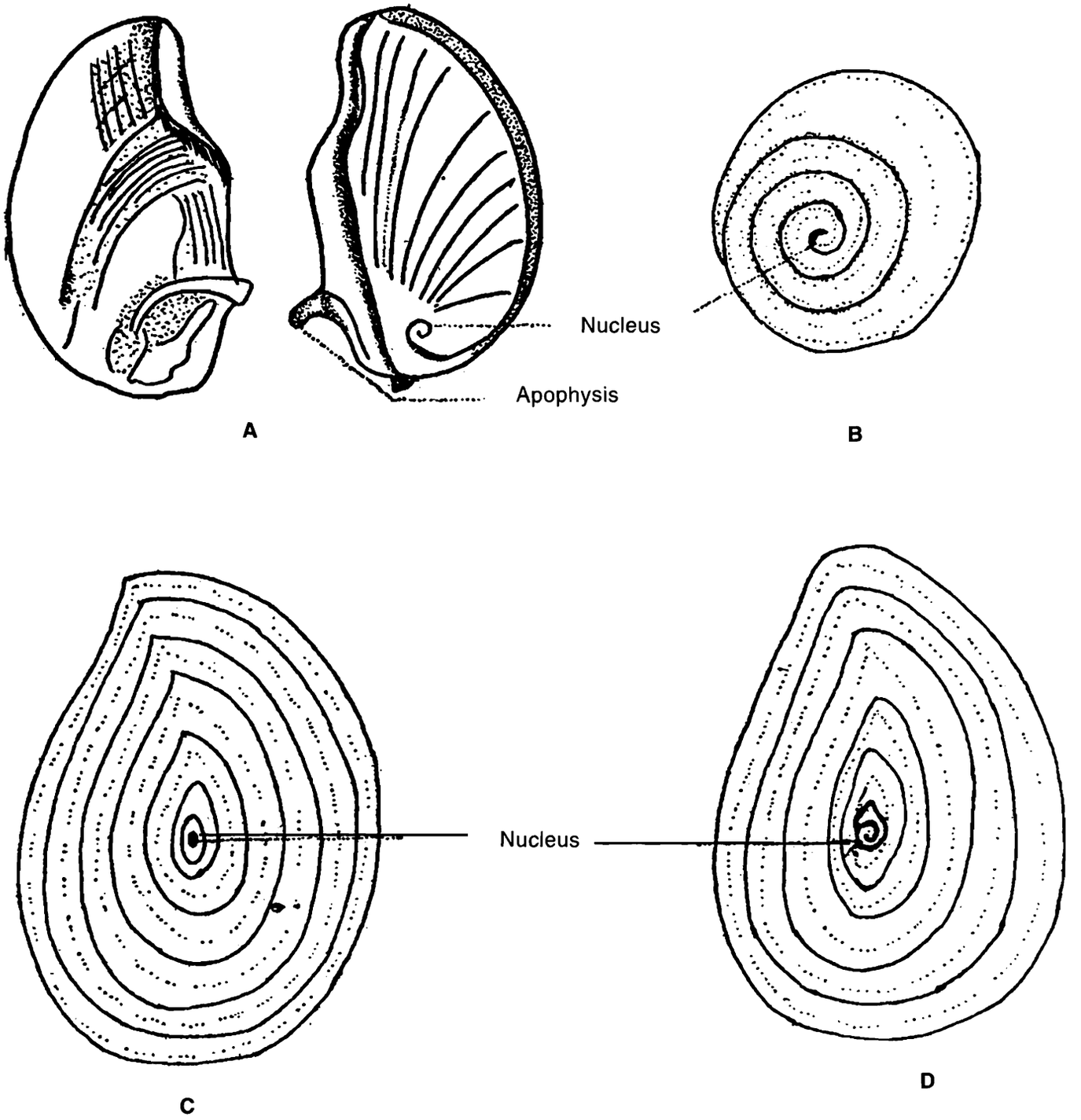


Fig. 12. Showing different types of opercula. **A** Paucispiral with concentric nucleus; **B** Multispiral; **C** Concentric with central nucleus; **D** Concentric with spiral nucleus.

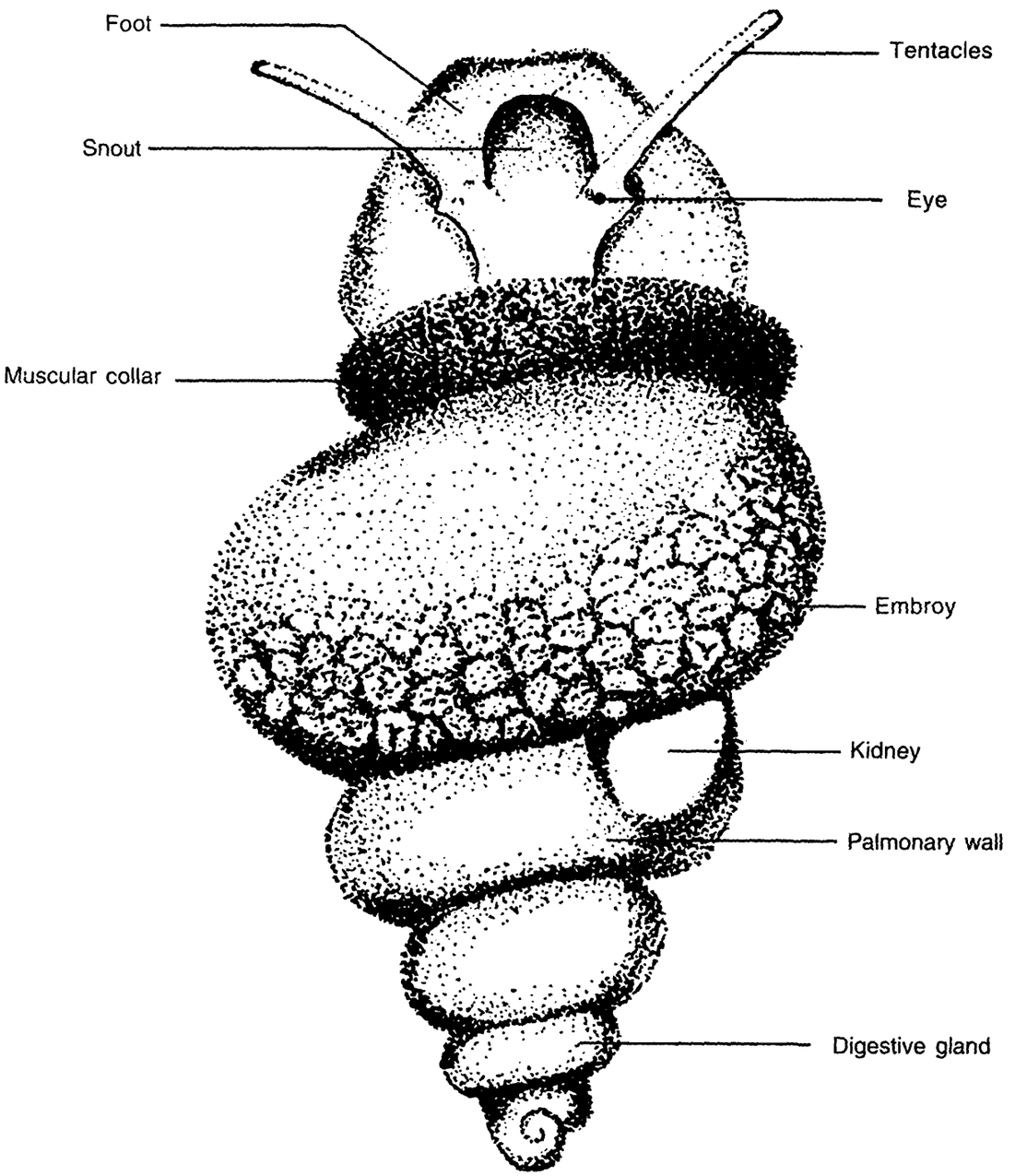


Fig. 13. Animal of *Bellamya bengalensis* (Lamarck) after removing the shell

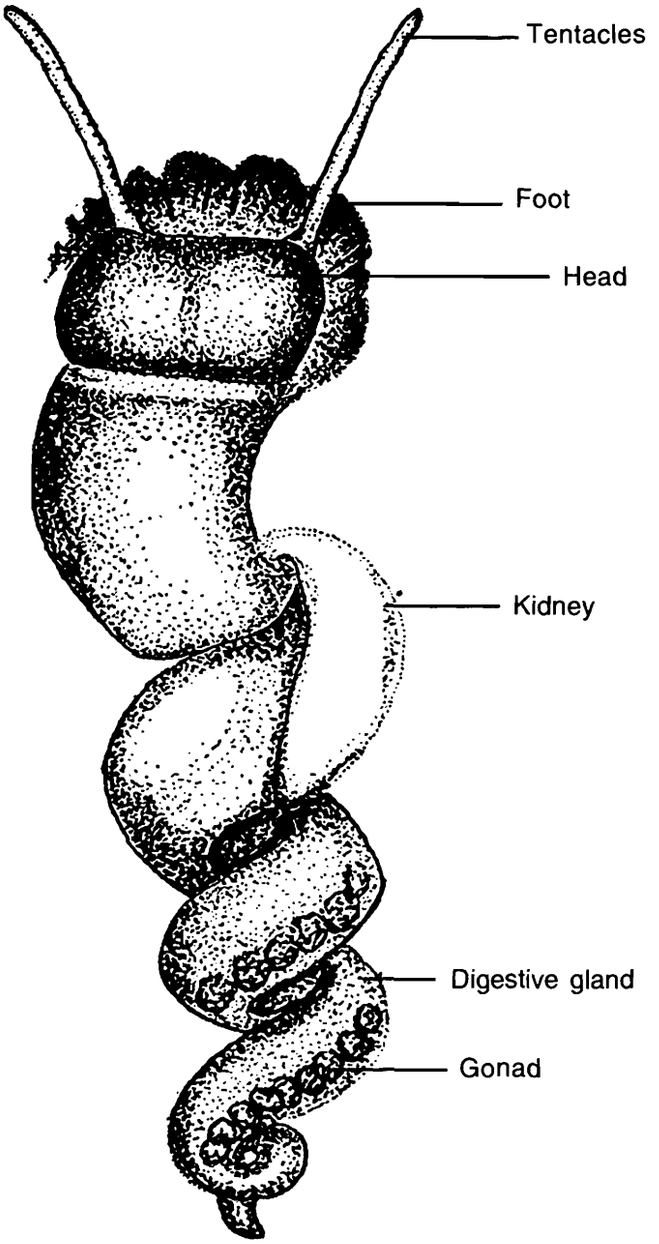


Fig. 15. Animal of *Brotia (Antimelania) costula* (Rafnesque) after removing the shell

The nervous system comprises of a numbers of ganglia, their commissures and connectives. The ganglia consist a pair of central ganglia situated above the pharynx; a pair of pleural or pallial ganglia of the sides of the pharynx; a pair of pedal ganglia below the pharynx and also a visceral ganglion, a supra-oesophageal ganglion and a sub-oesophageal ganglion. The characteristic feature of nervous system of gastropods is the crossing of pleurovisceral connectives in the shape of eight with one connective passing above and other below the foregut. This may be due to torsion which causes the migration of mantle cavity and pallial complex from its original posterior position along the right side to an anterior position. In pulmonates there is a strong condensation of visceral loop and also concentration of ganglia near the oesophagus.

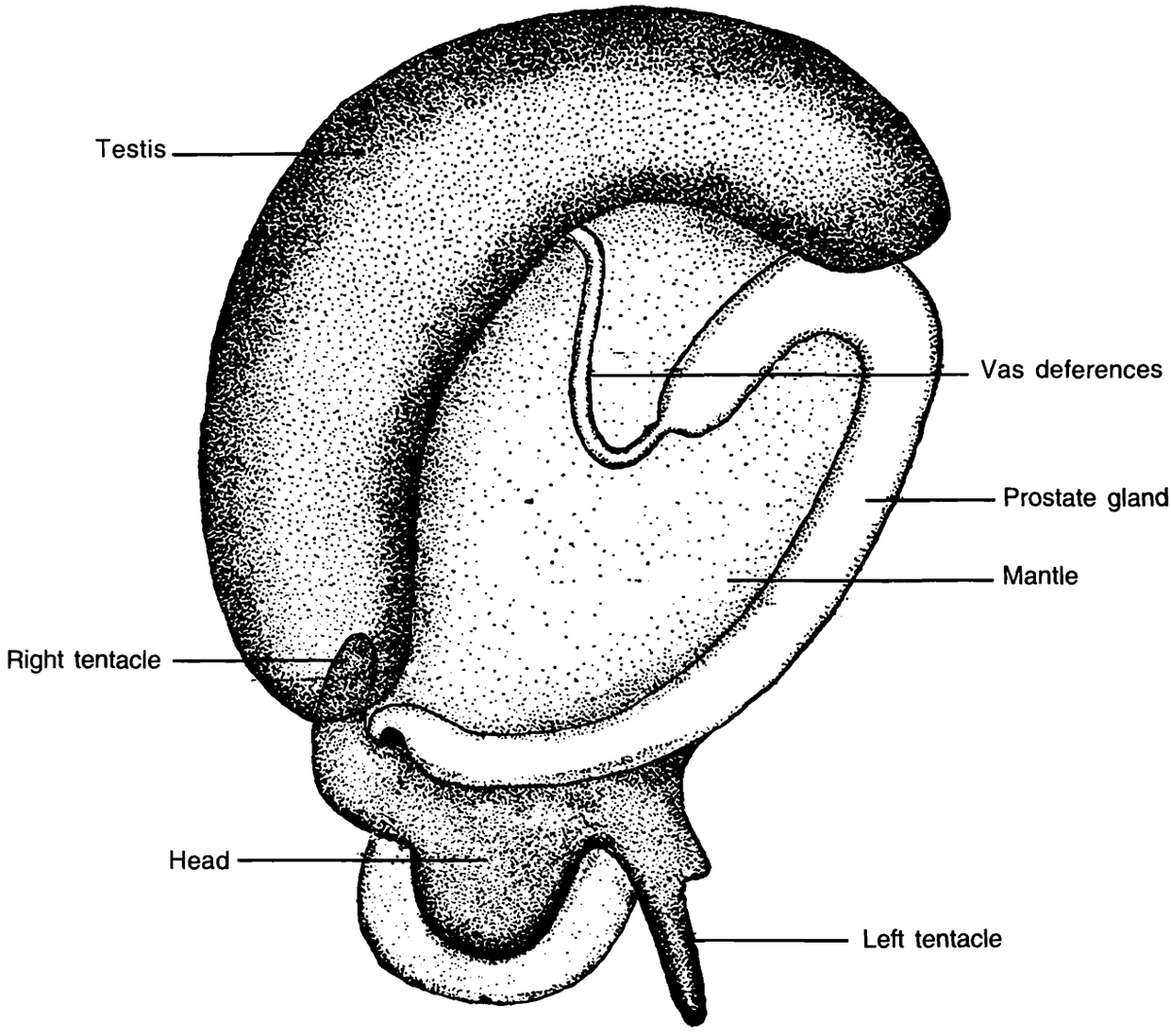


Fig. 15. Showing the male reproductive system of *Bellamya bengalensis* (Lamarck)

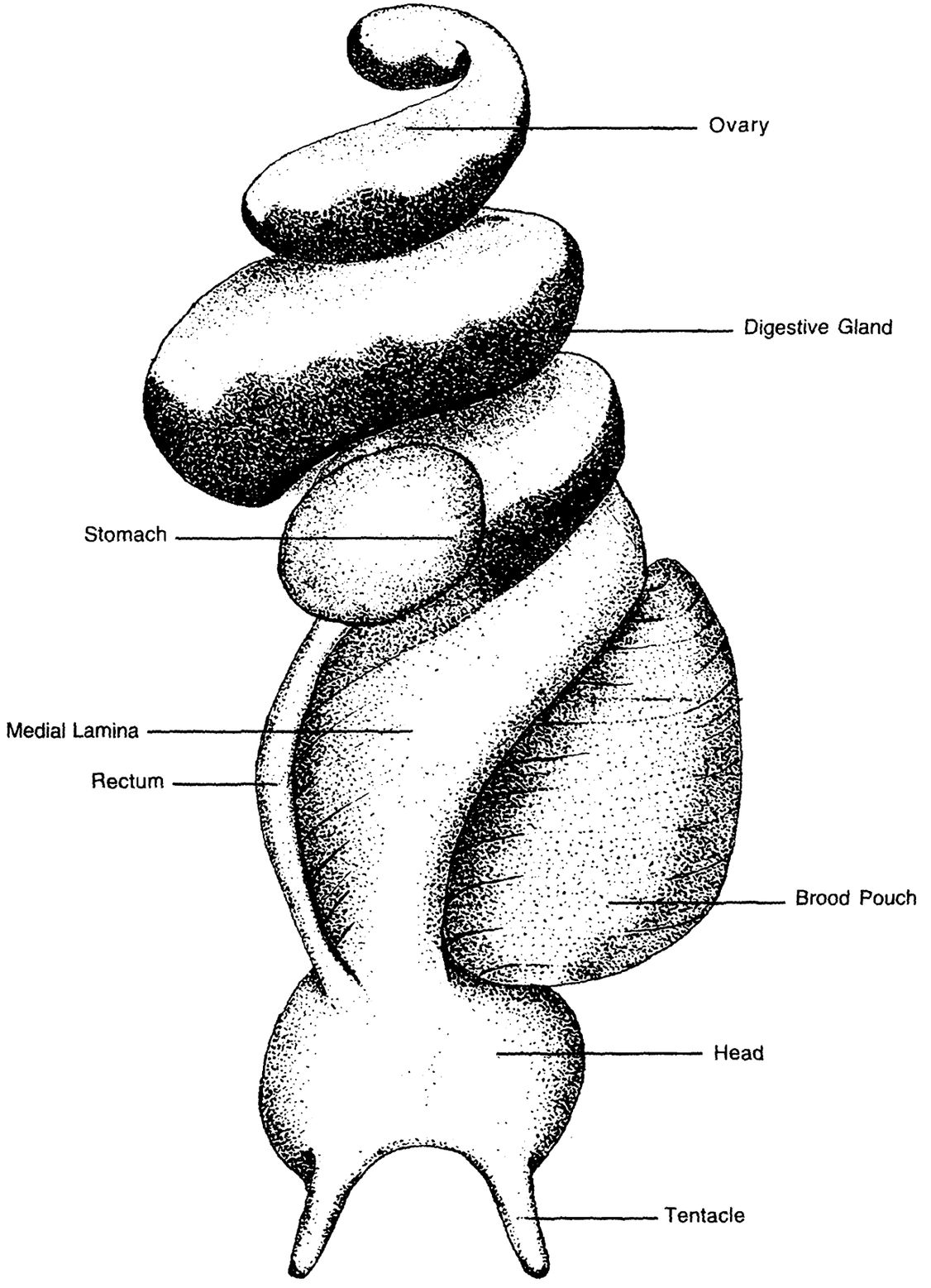


Fig. 16. Showing the female of *Brotia (Antimelania) costula* (Rafinesque) after removal of shell

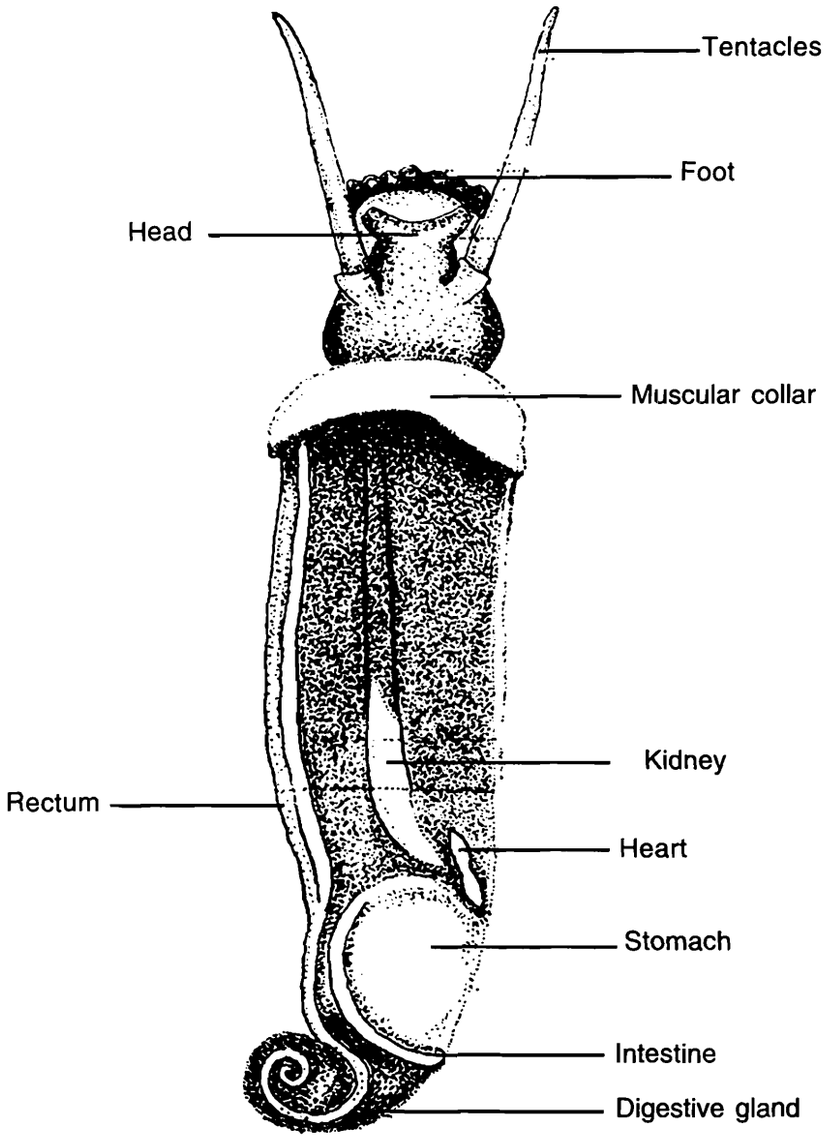


Fig. 17. Showing the animal of *Indoplanorbis exustus* (Deshayes) after removal of shell.

The excretory system consists of a kidney attached to the mantle close to pericardium and communicates with it by a reno-pericardial aperture. The adult kidney is on right or left depending on the direction of torsion, dextral or sinistral. The structure of kidney is also taxonomically important. Kidney may be located in visceral mass (e.g. *Bellamya*) or a small anterior part may project into the mantle cavity (e.g. *Brotia*).

The gastropods are dioecious or hermaphrodite. Most of Prosobranchs are dioecious whereas the pulmonates are hermaphroditic with a single hermaphrodite gonad and a gonoduct. The gonoduct is usually connected with the excretory duct and discharged through excretory pore. A few gastropods shed their sex cells into water where the fertilization takes place and develope into trochophore larva. Most of the gastropods have a definite copulatory organ and copulate with the internal fertilization. The eggs are then laid in a gelatinous string or masses or are enclosed in secreted capsules of various shapes. They hatch into baby snail as is also the case in ovoviviparous and viviparous species.

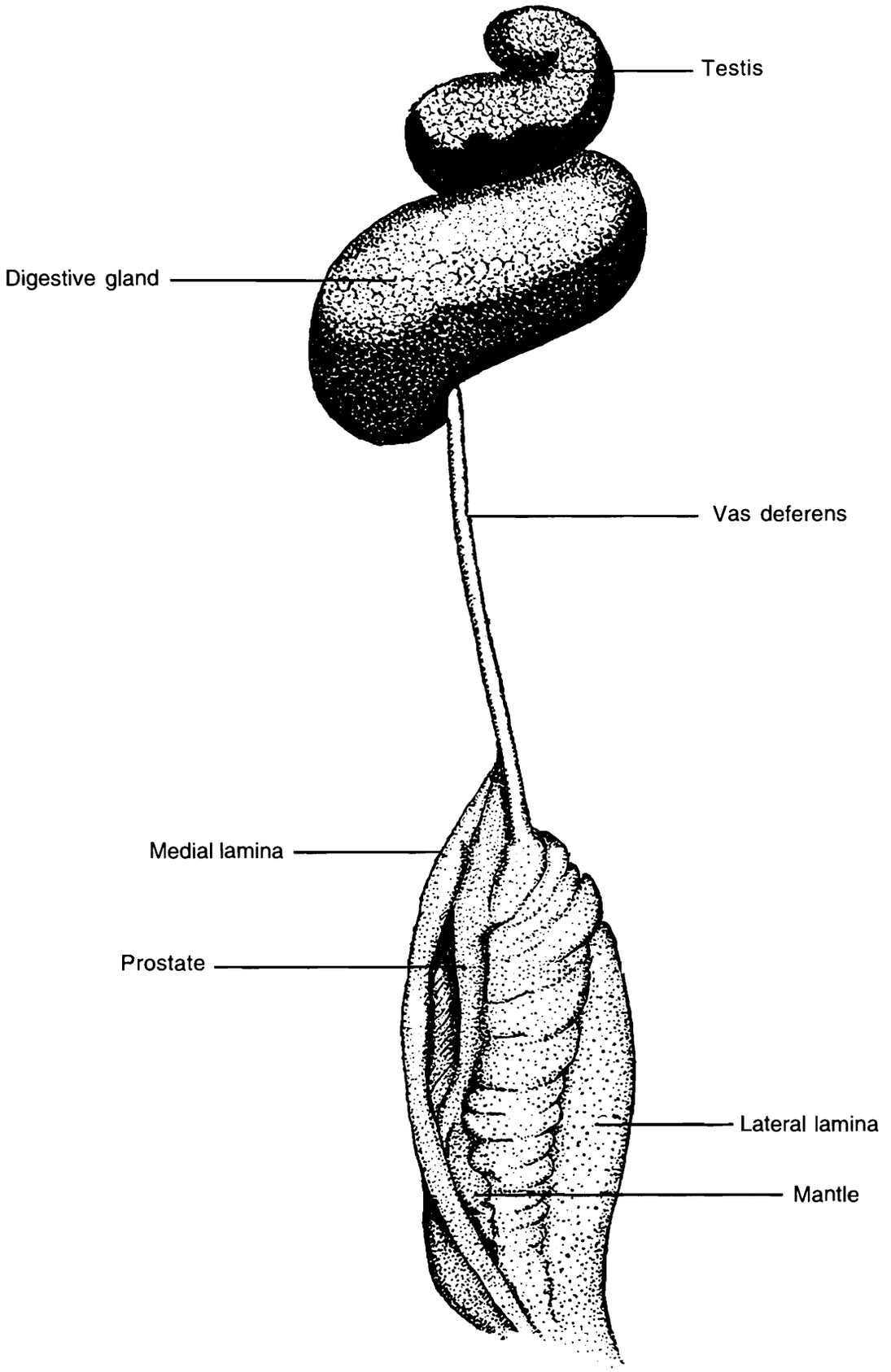


Fig. 18. Showing the male reproductive system of *Brotia (Antimelania) costula* (Rafinesque)

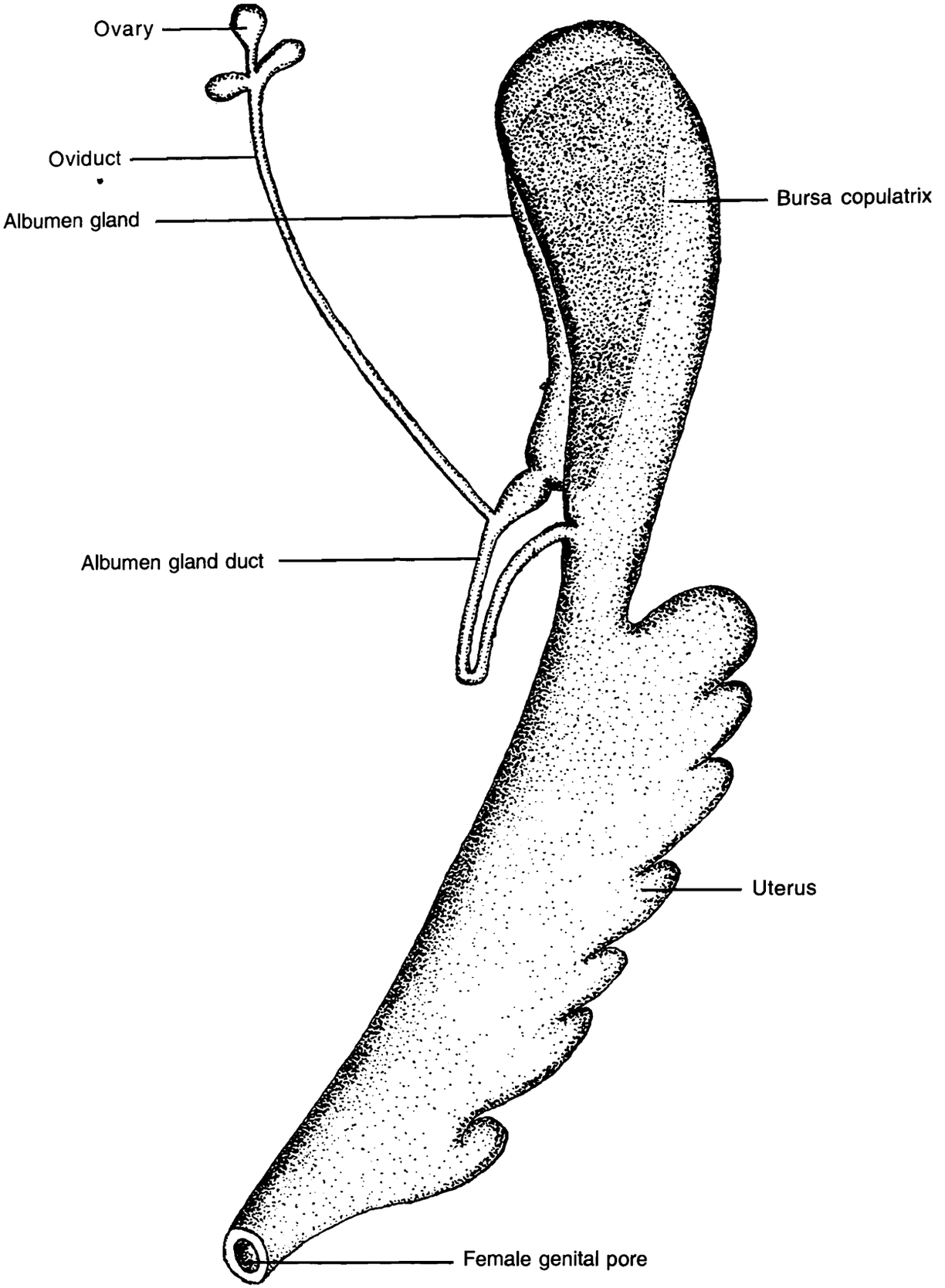


Fig. 19. Showing the female reproductive system of *Brotia (Antimelania) costula* (Rafinesque)

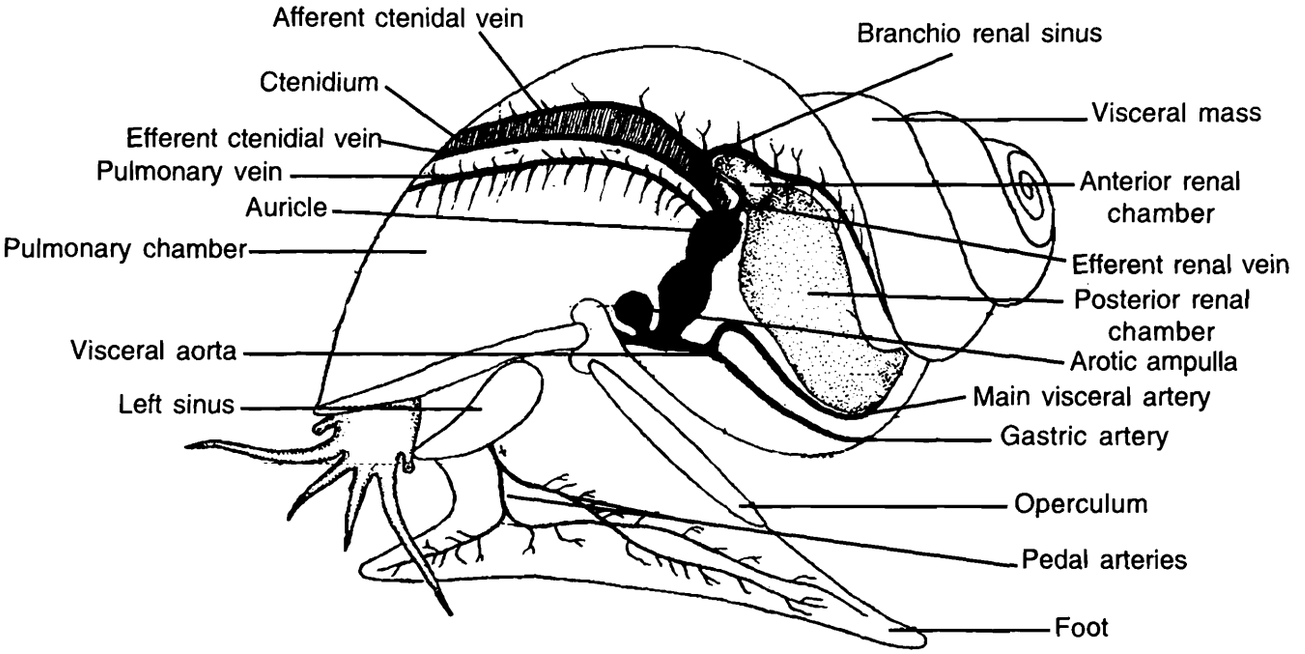


Fig. 20. Showing the heart and principal blood vessels of *Pila globosa* (Swainson), diagramatic

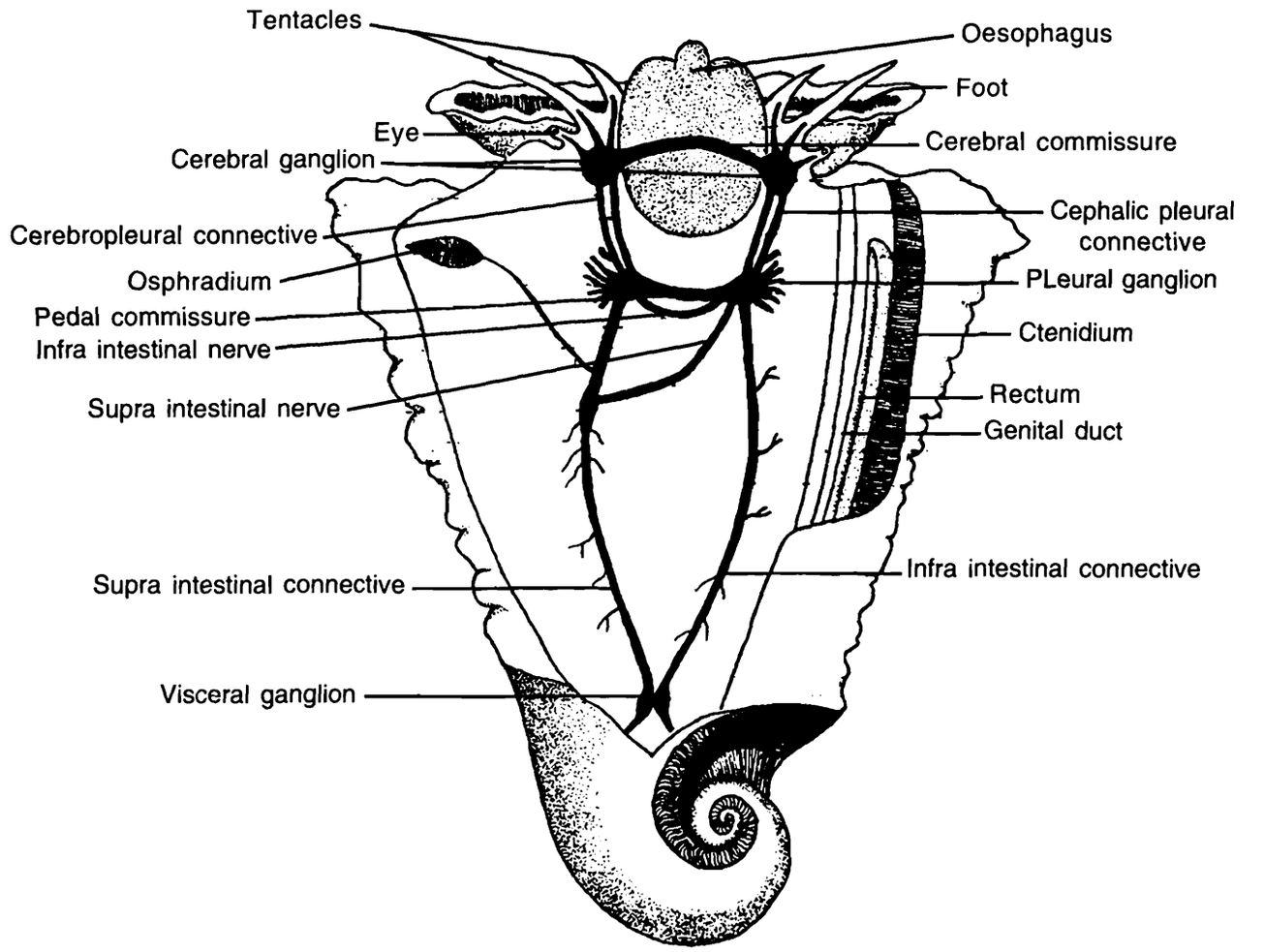


Fig. 21. Showing the nervous system of *Pila globosa* (Swainson)

Key to the families

1. Shell limpet shaped, without spiral coil ..... (2)
– Shell spirally coiled ..... (3)
2. Shell without operculum; apex obtuse or hook shaped ..... ANCYLIDAE
– Shell with operculum; apex small ..... SEPTARIIDAE
3. Shell without operculum ..... (4)
– Shell with operculum ..... (7)
4. Shell discoidal or when extended sinistrally coiled ..... (5)
– Shell dextrally coiled ..... LYMNAEIDAE
5. Shell sinistrally coiled; columellar axis twisted; animals with triangular tentacles ... . PHYSIDAE
– Shell discoidal or extended; columellar axis not twisted; animals with filiform tentacles ..... (6)
6. Shell discoidal (disc shaped); large, aperture ear shaped ..... BULLINIDAE
– Shell discoidal or planispiral; small with small aperture ..... PLANORBIDAE
7. Operculum with two apophysis, aperture D shaped; columellar area expanded and with callus deposit ..... NERITIDAE
– Operculum without apophysis, aperture oval or rounded; columellar area not expanded and without callus deposit ..... (8)
8. Operculum with spiral lines ..... (10)
– Operculum with concentric lines ..... (9)
9. Shell pyramidal; whorls regularly increasing; operculum horny; animals with gills only, labial palps absent ..... VIVIPARIDAE
– Shell globose; bodywhorl inflated and larger than spire; operculum calcareous; animals with gills and labial palps ..... AMPULARIDAE
10. Operculum ovate and paucispiral ..... (11)
– Operculum circular and multispiral ..... VALVATIDAE
11. Shell turreted or globose; mantle broader fringed and with brood pouch ..... (12)
– Shell globose or conical, mantle broader not fringed, without brood pouch ..... (13)
12. Shell elongate, turreted; columellar callus indistinct; operculum oblong with a terminal nucleus ..... THIARIDAE

– Shell either roundly ovate or elongate, turreted; columellar callus distinct; operculum round with usually central or subcentral nucleus ..... PLEUROCERIDAE

13. Animal with gill, generally found in stagnant freshwaters and often extending into brackish waters ..... (14)

– Animal with both gill and branchial chamber, found in hill streams ..... LITTORINIDAE

14. Eyes at tip of the tentacles; ciliated groove runs from mantle cavity to each side of foot to sole ..... ASSIMINEIDAE

– Eyes at base of the tentacles; no ciliated groove on side of foot ..... (15)

15. Operculum calcareous and concentric, as large as aperture; verge bifurcate ..... BITHYNIIDAE

– Operculum corneous, smaller than aperture; verge not bifurcate ..... (16)

16. Shell elongate and turreted; operculum without ridges on internal surface ..... (17)

– Shell compressed in its dorso ventral axis; operculum with two prominent ridges on internal surface ..... STENOTHYRIDAE

17. Whorls with strong spiral ridges; operculum horny, nucleus nearer to the inner margin ..... IRAVADIIDAE

– Whorls without strong spiral ridges; operculum paucispiral ..... (18)

18. Operculum transparent; snout short and broad; radular central with 2-3 lateral dentition on either side ..... POMATIOPSIDAE

– Operculum corneous; snout long, terminally divided a little; radular central tooth broader than long with one or more basal dentition ..... HYDROBIIDAE

Class GASTROPODA

Subclass PROSOBRANCHIA

Order ARCHAEOGASTROPODA

Superfamily NERITOIDEA

Family NERITIDAE

Small to medium sized shell, dextral of diverse shape, commonly hemispherical with D-shaped aperture having a straight side formed by a columellar plate. Many species with variable pattern of dark markings on a light background. Operculum thick, semilunar and calcified. The rib and peg project from the inner surface of the operculum.

Respiration with a single bipectinate gill; Tentacles long and slender, eyes on pedicles at the external base of tentacles. Radula long ribbon like and rhipidoglossate a-5-1-5-a. Baker (1923) gave importance radula in classification of this group. Right auricle absent or reduced. Sexually dimorphic. Male with a cephalic penis on the right side, produces spermatophores. Females with a crescent shaped ridge by the side of right tentacles, oviparous, with complicated reproductive system, 2-3 gonopores in female. Eggs laid in capsules dehiscent, with two valves.

The family Neritidae includes both marine and freshwater members. The freshwater genera *Neritina*, *Neritodryas* and *Theodoxus* contain about 20 species in the Indo-pacific region living among river banks, or in the spring at the foot of the waterfalls.

Significant contributions to the family were made by Andrews (1937), Baker (1923), Martens (1879, 1889), Reeve (1855-1856), Sowerby (1849, 1850), Tryon (1888). Contributions on freshwater neritids are by Benthem Jutting (1956), Pace (1973) and Starmuehlner (1970, 1974, 1976); Andrew (1933, 1935, 1937), Baker (1923), Bourne (1908), Fretter (1946, 1965, 1966), Gilson (1896) and Lenssen (1899) on habits and reproductive organs.

So far the Indian neritids are concerned Govindan (1974), Govindan and Natarajan (1972) and Subba Rao (1975), workout the detail taxonomy of the family.

Subfamily NERITINAE

Key to the Genera

1. Shell with more or less longitudinal and coarse striae or with fine spiral striae, sometimes with spines; verge and vaginal spout very complex ..... ***Theodoxus*** Montfort

– Shell surface smooth and shining, never with spines; verge and varginal spout not very complex 2

2. Operculum with longitudinal grooved, ridges with finger like projections at the free end; inner marginal teeth of radula with 2-4 denticles alonge cutting edge and blades with strong accessory cusps ..... ***Neritodryas*** Von Martens

– Operculum's rib not grooved, ridges devoid of finger like projections; inner margin of radula with many denticles along cutting edge and blades without strong accessory cusps ..... ***Neritina*** Lamarck

Genus *Neritina* Lamarck

1816. *Neritina* Lamarck, *Encycl. Meth. Vers.*, **2** : 155. Type species : *Nerita pulligera* Linnaeus, subsequent designation by Children, 1823.

Shell small to medium with strongly developed rib and peg of the operculum, the lower ridge connecting the rib and peg. The outer lip without toothed. Egg capsule oval, 1-2 mm long, often seen on shells.

Predominantly marine, but present in brackish and freshwaters near coastal areas throughout the tropical region. Vaught (1989) included eleven subgenera under genus *Neritina*, four subgenera namely *Neritina, Dostia, Neripteron* and *Vittina* are represented from brackish and freshwaters in Indian region

Key to the subgenera

- Shell with flat base; spire depressed; columellar callus broad .....(2)
- Shell globose or oval; spire pointed; columellar callus small and concave .... ***Vittina*** H.B. Baker
- Peristome without wings; columellar edge not attached to last whorl.....(3)
- Peristome with wings; columellar edge attached to last whorl .. ***Neripteron*** Lesson
- Shell dorsally strong, arched; spire lateral and vestigial; columellar callus extend as a transverse septum along the aperture; peg and ribs comparatively less developed .....***Dostia*** Gray
- Shell dorsally rounded; spire hidden by last whorl; columellar callus does not extends as a transverse septum along the aperture; aperture with well developed peg and ribs .....***Neritina*** s. st.

Subgenus ***Neritina*** s. st.

Neritina (Neritina) pulligera (Linnaeus, 1967)

1967. *Nerita pulligera* Linnaeus, *Syst. Nat. ed.*, **12** : 1253, no. 726. (Type locality : Rivers India).

1956. *Neritina pulligera* : Benthem Jutting, *Treubia*, **23(2)** : 307, fig. 24.

Fig. 22 A. Dorsalm view of *Neritina (Neritina) pulligera* (Linnaeus)

Fig. 22 A. Ventral view of *Neritina (Neritina) pulligera* (Linnaeus)

Type location : Linnaean Society, London, not found (Brandt, 1974).

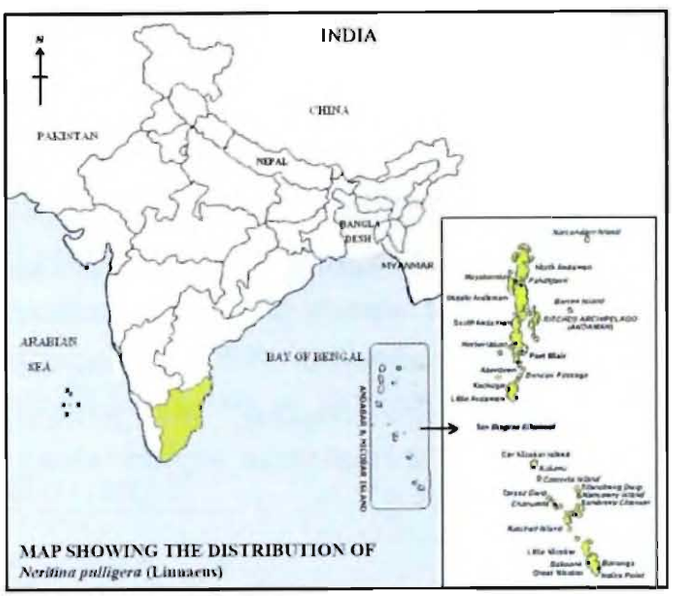
Latest name and Reference : *Neritina (Neritina) pulligera* : Subba Rao, 1989 *Handbook of Freshwater Molluscs of India*, p. 34, figs. 17-21.

Diagnosis : Shell very thick with a thick and wide columellar callus, callus with fine granulations, bluish black on the outer half and gradually fading to inner half, outerlip thick with a deep orange band on its inner margin, operculum with a sharp and longitudinally grooved sickle shaped rib and a conical peg having a rounded top.

Pace (1973) gave a detailed account of this species and pointed to the possibilities of sexual dimorphism in the shell.

Distribution : India : Andaman and Nicobar Islands, Tamil Nadu.

Elsewhere : Eastern coast of Africa from Kenya to South Africa, Malagasy (Brown, 1980). Thailand, Indonesia, Moluccas, Celebes, North-western Australia, New Guinea, New Caledonia, Fiji, Philippines and Japan



Subgenus ***Dostia*** Gray, 1840

1840. *Dostia* Gray, *Syn. Cont. Brit. Mus., ed.* **42** : 147. Type species : *Neritina crepidularia* Lamarck.

Shell obliquely elongated; spire indistinct; columellar callus extending as a tranverse septum alonge the aperture; inner columellar margin twisted.

Mainly esturaine oassionally found in freshwater.

Key to the species

- Shell thick, ovate, crepidula shaped, dorsal side arched, columellar plate porcellaneous, smooth ..... *N. (D.) violacea* (Gmelin)

- Shell thin and translucent, broadly oval and slightly truncated posteriorly, dorsal side less arched, columellar plate separated from the lower margin of the shell..... ..... *N. (D.) platyconcha* (Annandale and Prashad)

Neritina (Dostia) platyconcha (Annandale and Prashad, 1919)

1919. *Dostia platyconcha* Annandale and Prashad, *Rec. Indian. Mus.*, **16** : 244. (Type locality : Burdul, Kahaduk river, Khulna, Bangladesh.

Fig. 23. A. Dorsal view of *Neritina (Dostia) platyconcha* (Annandale and Prashad)

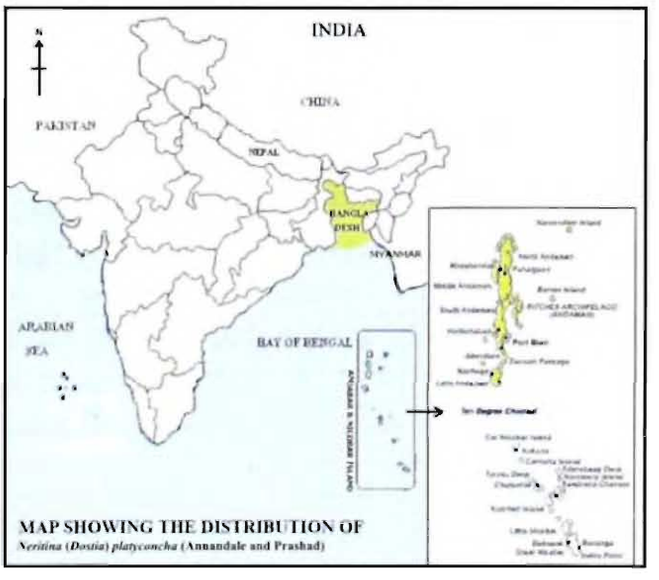
Fig. 23. B. Ventral view of *Neritina (Dostia) platyconcha* (Annandale and Prashad)

Type location : National Zoological Collection, ZSI, Reg. No. M 11440/2 (Holotype).

Latest name and Reference : *Neritina (Dostia) platyconcha* : Subba Rao, 1989 *Handbook of Freshwater Molluscs of India*, p. 38, fig. 35-37.

Diagnosis : Shell thin, transluscent, broadly oval and slightly truncated posteriorly. Spire minute, hardly protrudes beyond the anterior margin of the body whorl. Shell olivaceous green with minute specks and with obscure longitudinal rays. Aperture small, colomellar plate separated from the lower margin of the shell and extend more than half way across its mouth; peristome and aperture porcellaneous; operculum rather short.

Distribution : Known from type locality only.



Neritina (Dostia) violacea (Gmelin, 1791)

1791. *Nerita violacea* Gmelin, *Syst. Nat. ed.*, **13** : 3686, no. 68. (Type locality : not mentioned).

1965. *Neritina violacea* : Benthem Jutting, *Treubia*, **23(2)** : 300, fig. 21.

Type location : Not known.

Fig. 24. A. Dorsal view of *Neritina (Dostia) violacea* (Gmelin)

Fig. 24. B. Ventral view of *Neritina (Dostia) violacea* (Gmelin)

Latest name and Reference : *Neritina (Dostia) violacea* : Subba Rao, 1989 *Handbook of Freshwater Molluscs of India*, p. 37, figs. 30, 31.

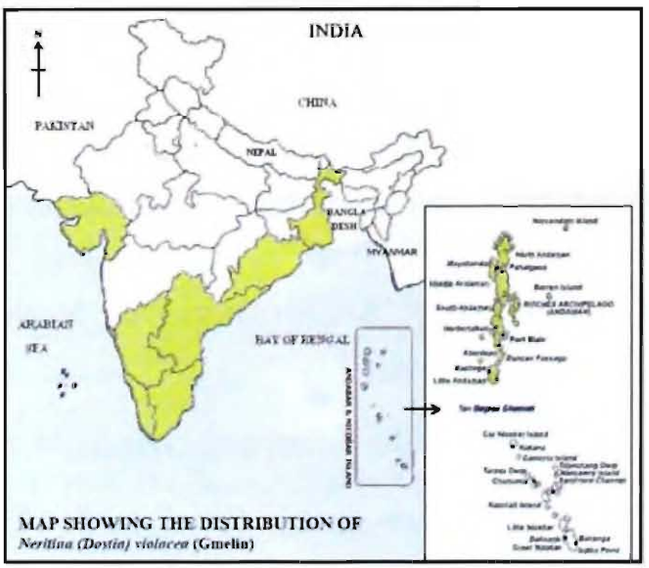
Diagnosis : Shell thick, ovate, crepidula shape, whorls 2, spire minute, anteriorly twisted inwards, protruding out as a beak; peristracum yellowish-brown; aperture broad, columellar plate porcellaneous, operculum semilunar; radula with the central having a little broader cusp, cusp of the v-lateral not very large.

Remarks : Commonly occurs in creeks and rivers with tidal influence. Found adhering to the roots and branches of the trees and also creeping on the mudflat. Variable in shape, colour and even structure of shell.

Woodward (1892) studied the growth and structure of shell; Annandale (1921), Baker (1923) radula; Govindan and Natarajan (1972) morphology, reproductive system; Murthy and Balaparameswara Rao (1978) effect of environment on shell shape.

Distribution : India : Andaman Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Orissa, Tamil Nadu and West Bengal.

Elsewhere : Sri Lanka, Myanmar, Thailand, Cambodia, Vietnam, Singapore, Indonesia, Timor, New Caledonia, Samoa, Fiji, Australia, Philippines and Japan.



Subgenus *Neripteron* Lesson, 1830

1830. *Neripteron* Lesson, *Voy. Coquille zool.*, **2(1)** : 384. Type species : *Neritina taitensis* Lesson.

Shell with flat base and rounded dorsal side; spire not projecting; aperture wide, sourronded by broad periostome which ends in two divergent auricles, columellar edge of aperture attached to body whorl.

Indo-pacific. Found in frehswater and brackish water.

Neritina (Neripteron) auriculata Lamarck, 1826

1826. *Neritna auriculata* Lamarck, *Encycl. Meth. Vers. Planches.*, pl. 455., fig. 6. (Type locality : New Holland).

1974. *Neritina (Neripteron) auriculata* : Starmuehlner, *Bull. Fish. Res. Stn.*, Sri Lanka, **25**(1-2) : 108, figs. 5-8.

Fig. 25. A. Dorsal view of *Neritina (Neripteron) auriculata* Lamarck

Fig. 25. B. Ventral view of *Neritina (Neripteron) auriculata* Lamarck

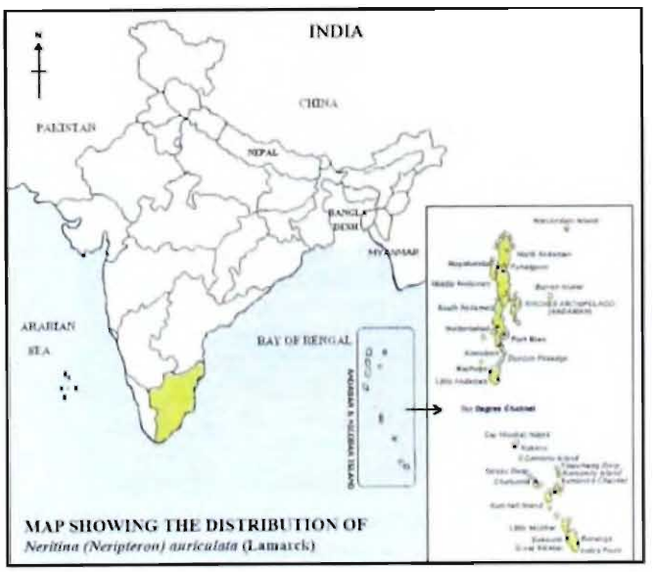
Type location : Museum D'Histoire Naturelle, Geneva.

Latest name and Reference : *Neritina (Neripteron) auriculata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 37, figs., 38-44.

Diagnosis : Shell semiglobular with wide aperture and a well developed columellar callus. Peristome broad and produced into two "auricles" or "wings" at the upper and lower columellar sides.

Distribution : India : Andaman and Nicobar Islands, Tamil Nadu: Porto Novo.

Elsewhere : Malagasy, Sri Lanka, Indonesia, Moluccas, New Ireland, Australia, New Caledonia and Philippines.



Subgenus *Vittina* Baker, 1923

1923. *Vittina* Baker, *Proc. Acad. Nat. Sci. Philad.*, **75** : 144. Type species : *Nerita roissyana* Recluz.

Shell oval or globose; spire pointed, columellar callus small, concave; inner columellar margin toothed.

Key to the species

1. Spire elevated; shell with colour bands or stripes ..... (2)

– Spire short; shell with fine longitudinal striae, shinning, and colour uniformly black or olive ..... *N. (V.) perottetiana* (Recluz)

2. Spire sub conical, columellar callus with colour spots; operculum black externally ..... (3)

– Spire conical, columellar callus porcellanous white; operculum yellow externally .. .. *N.(V.) turrita* (Gmelin)

– Spire short and distinct; aperture bluish white, columellar callus with orange red spot on lower half of its margin ..... *N. (V.) variegata* Lesson

– Spire prominent; aperture yellowish white, columellar callus with orange brown tint on the upper margin ..... *N. (V.) smithi* Wood

Neritina (Vittina) perottetiana (Recluz, 1841)

1841. *Nerita perottetiana* Recluz, *Revue Zool. Soc. Cuvier* : 337. (Type locality : Nilgiri Hills, India).

1915. *Theodoxus perottetiana* : Preston, *Fauna Brit. India, Mollusca* (Freshwater Gastropod and Pelecypoda) : 5.

Fig. 26. A. Dorsal view of *Neritina (Vittina) perottetiana* (Recluz)

Fig. 26. B. Ventral view of *Neritina (Vittina) perottetiana* (Recluz)

Type location : Museum National D'Histoire Naturelle, Paris.

Latest name and Reference : *Neritina (Vittina) perottetiana* : Subba Rao, 1989. *Handbook of Freshwater Molluscs of India,* p. 36, fig. 34.

Diagnosis : Shell semiglobose and smooth, operculum thin and externally light gray, inner columellar margin straight with 5-10 indistinct denticulations or sometimes smooth.

MAP SHOWING THE DISTRIBUTION OF *Neritina (Vittina) porottetiana*

Distribution : India : Tamil Nadu (Streams in the Nilgiri hills). Though Preston (1915) reported this species from Sri Lanka Starmuehlner's (1976) report does not include this from Sri Lanka.

Remarks : This species is endemic to Western Ghat only.

Neritina (Vittina) smithi Wood, 1828

1828. *Neritina smithi* Wood, *Index Test. Suppl.*, p. 26. pl. 8, fig. 11. (Type locality : River Hooghly, Calcutta).

1888. *Neritina smithi* : Tryon, *Man. Conch.*, **10** : 37, pl. 10, fig. 96.

Type locations : Natural History Museum, London.

Latest name and Reference : *Neritina (Vittina) smithi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India,* p. 36, figs. 28, 29.

Fig. 27. A. Dorsal view of *Neritina (Vittina) smithi* Wood

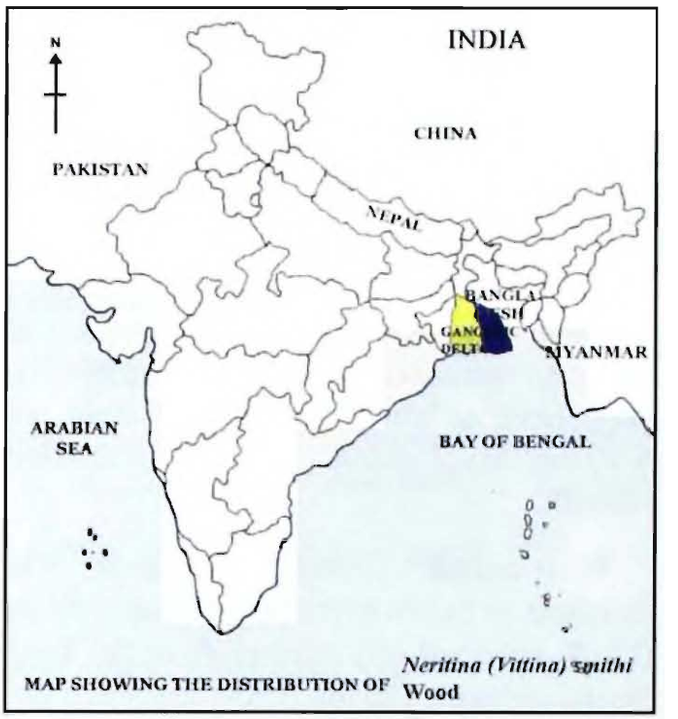
Fig. 27. B. Ventral view of *Neritina (Vittina) smithi* Wood

Diagnosis : Shell solid, oval, higher than broad, whorls 5, gradually increasing, spire subconical, apex blunt, shell smooth and glistening, aperture broad, semilunar. Columellar callus, small and smooth. Columellar margin with 13-15 teeth. Outer lip thickened operculum semilunar, black or light flesh colour. Shell white or dull brown with strong black, longitudinal, undulating and interrupting lines and bands.

Distribution : India : West Bengal : Gangetic estuary.

Elsewhere : Myanmar : Irawaddy estuary.

Remarks : A brackish water species occasionally found in freshwater.



MAP SHOWING THE DISTRIBUTION OF *Neritina (Vittina) smithi* Wood

Neritina (Vittina) turrita (Gmelin, 1791)

1791. *Nerita turrita* Gmelin, *Syst. Nat. ed.* **13** : 3686, no. 71. (Type locality : Islands of Antilles).

1976. *Neritina (Vittina) turrita* : Starmuehlner, *Ann. Naturhist. Mus. Wien.*, **80** : 514.

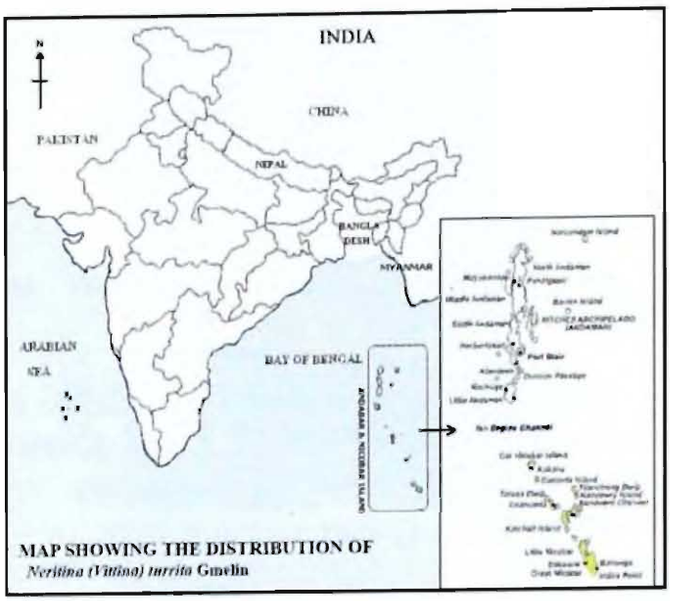
Type locations : Not known.

Latest name and Reference : *Neritina (Vittina) turrita* : Subba Rao, 1989. *Handbook of Freshwater Molluscs of India*, p. 36, figs. 26, 27.

Fig. 28. A. Dorsal view of *Neritina (Vittina) turrita* (Gmelin)

Fig. 28. B. Ventral view of *Neritina (Vittina) turrita* (Gmelin

Diagnosis : Shell thick, oblong, globose, whorls 4, rapidly increasing, convex in general but concave just below the suture. Spire elevated, body whorl longer than broad, suture shallow periphery rounded, aperture broad, crescentric, rather oblique. Columellar callus, porcellaneous, white. Inner collumellar margin with 16-17 distinct teeth. Operculum semilunar externally, smooth and yellowish in colour.



Distribution : India : Nicobar Islands : Kamorta and Car Nicobar.

Elsewhere : Indonesia, Moluccas, New Caledonia, New Guinea, Marianas, Palaus, Carolines, Philippines.

Neritina (Vittina) variegata Lesson, 1831

1831. *Neritina variegata* Lesson, *Voy. Coquille. Zool.*, **2** : 378. (Type locality : New Ireland).

1956. *Neritina variegata* : Benthem Jutting, *Treubia*, **23(2)** : 306, fig. 29.

Type location : Museum National D'Histoire Naturelle, Paris.

Latest name and Reference : *Neritina (Vittina) variegata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 35, figs. 22, 23.

Diagnosis : Shell oval, with short but distinct spire, surface smooth and polished with colour pattern of zig-zag markings, network or black spiral bands, aperture bluish

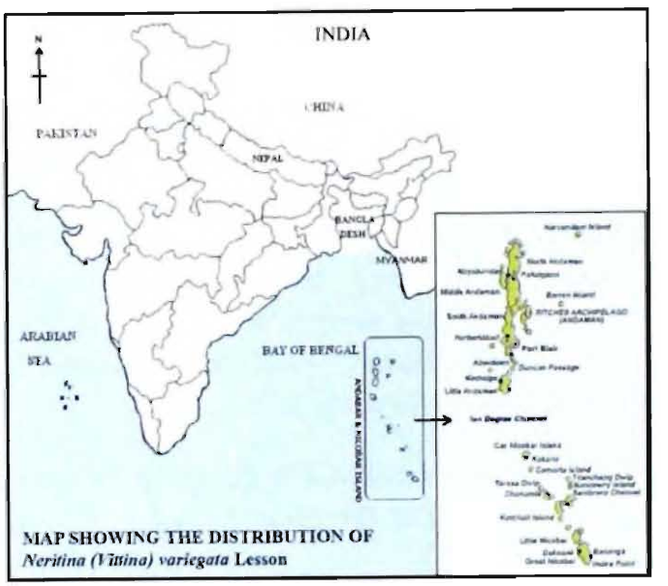
Fig. 29. A. Dorsal view of *Neritina (Vittina) variegata* Lesson

Fig. 29. B. Ventral view of *Neritina (Vittina) variegata* Lesson

white, columellar callus with an orange rec spot on the lower half of its outer margin inner columellar edge generally straight witl 8-11 weak denticulations, spire short bu distinct.

Distribution : India : Andaman anc Nicobar Islands.

Elsewhere : Indonesia, Moluccas Australia, New Caledonia, New Guinea New Ireland, Samoa, Fiji, Tahiti anc Philippines.



Genus ***Neritodryas*** von Martens, 1869

1869. *Neritodryas* von Martens, *Sitz. Gessell. Nature. Freunde Berlin,* p. 21. (Type species : *Nerita cornea* Linnaeus.

Shell with small spire and large bodywhorl; suture shallow; aperture semilunar; columellar callus broad, inner columellar margin slightly curved or staight; outer lip sharp and thickened; operculum thick, semilunar.

Distributed throughout tropical Asia. Members are terrestrial and found adhering to stones or other substrata by the sides of streems.

Neritodryas subsulcata (Sowerby, 1836)

1836. *Neritina subsulcata* Sowerby, *Conch. Illustrations,* No. **50,** fig. 50. (Type locality : Philippine Islands)

Fig. 30. A. Dorsal view of *Neritodryas subsulcata* (Sowerby)

Fig. 30. B. Ventral view of *Neritodryas subsulcata* (Sowerby)

Fig. 31. A. External view of operculum of *Neritodryas subsulcata* (Sowerby)

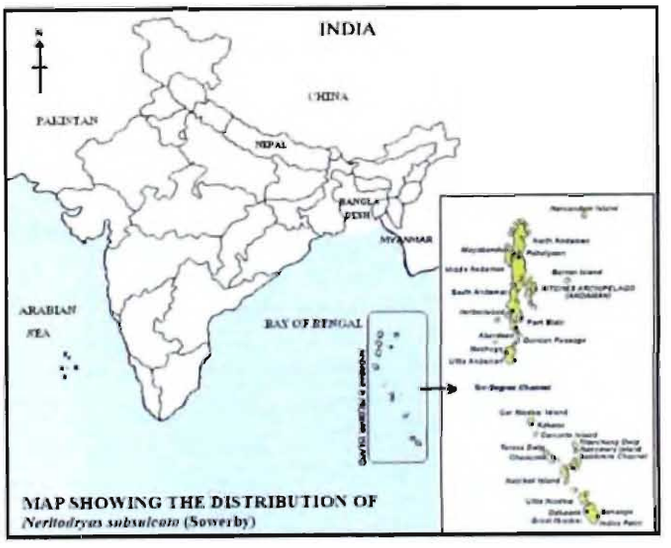
Fig. 31. B. Internal view of operculum of *Neritodryas subsulcata* (Sowerby)

1956. *Neritodryas subsulcata* : Benthem Jutting, *Treubia*, **23** : 294; fig. 18.

Type location : Not known.

Latest name and Reference : *Neritodryas subsulcata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 40. figs. 47, 48.

Diagnosis : Shell blackish brown with yellowish brown markings. Sculpture consists of conspicuous broad spiral ribs with distinct grooves in between and crossed by fine longitudinal striations. Aperture broad and bluish white, columellar callus wide, bluish-white with clouded black penetrating from the outer margin. Operculum thick, externally black, nucleus white, internally orange brown, rib sickle shaped and strongly grooved, terminating in 8-10 finger-shaped lobes at the free end, peg strong and flattened.



Distribution : India : Andaman and Nicobar Islands.

Elsewhere : Indonesia, Moluccas, New Hebrides, Fiji, Philippines.

Genus ***Theodoxus*** Montfort, 1810

1810. *Theodoxus* Montfort, *Conch. Syst.*, **2** : 326. Type species : *Nerita fluviatilis* Linnaeus.

Shell small to median size. Baker (1923) recognised two group of species, one has peg on the operculum markedly reduced and found in Europe, whereas the others has

slender peg but clearly visible found in Egypt and South-West Asia and both the two groups overlaps in Iraq and Iran.

Subgenus ***Clithon*** Montfort, 1810

1810. *Clithon* Montfort, *Conch. Syst.*, **2** : 326. Type species : *Nerita corona* Linnaeus.

Shell small to median, coarsely or finely striated, a comparatively high ridge between the peg and rib on the operculum. Aperture small with a narrow concave columellar callus; inner columellar margin finely distributed with a large superior tooth. Some species have stout species.

Widely distributed in the Indo-pacific region.

Subba Rao (1989) reported five species of this Subgenus from India, out of which three species are found in freshwater streams.

Key to the species

1. Shell finely striated; spire entirely hidden by last whorl; inner columellar margin with less than 12 denticles ..... *T. (C.) reticularia* (Sowerby)

– Shell coarsely striated; spire distinct and projecting from last whorl; inner columellar margin with more than 12 denticles ..... (2)

2. Shell dull yellowish or greenish, very coarsely sculptured; generally with spire; outer margin of peristome thickened ..... *T. (C.) corona* (Linnaeus)

– Shell olive green with small dark squares, moderately sculptured; without spire; outer margin of peristome not thickened..... *T. (C.) bicolor* (Recluz)

Theodoxus (Clithon) bicolor (Recluz, 1842)

1842. *Nerita bicolor* Recluz, *Proc. zool. Soc. Lond.*, **1842** : 172. Type locality : Agoo (in a mountain stream), Philippines.

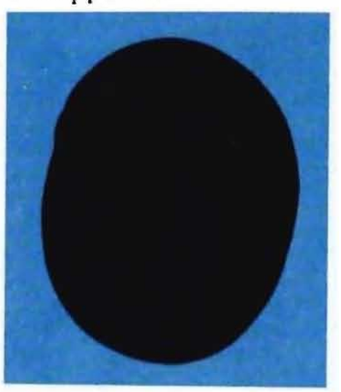


Fig. 32. A. Dorsal view of *Theodoxus (Clithon) bicolor* (Recluz)

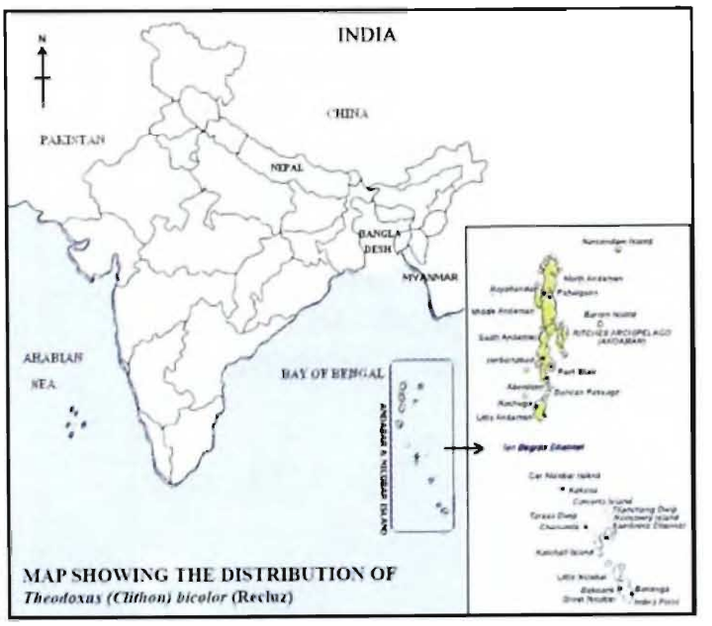
Fig. 32. B. Ventral view of *Theodoxus (Clithon) bicolor* (Recluz)

1947. *Theodoxus (Clithon) bicolor* : Ray, *Rec. Indian. Mus.*, **45(4)** : 308.

Type location : Not known.

Latest name and Reference : *Clithon (Clithon) bicolor* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 39, figs. 24, 25.

Diagnosis : Shell is generally olive-green or olive-brown with small dark squares and the spire is more produced than in the *T. (C.) corona* Linnaeus.



Distribution : India : Andamans.

Elsewhere : Indonesia, Moluccas, Philippines and Formosa.

Theodoxus (Clithon) corona (Linnaeus, 1758)

1758. *Neritina corona* Linnaeus, *Syst. Nat. ed.* **10** : 777.

1956. *Clithon corona* : Benthem Jutting, *Treubia,* **23(2)** : 275, figs., 1 and 2.

1976. *Clithon (Clithon) corona* : Starmuehlner, *Ann. Naturhist. Mus. Wien*, **80** : 494, figs. 2-5.

Type location : Linnean Society, London.

Latest name and Reference : *Clithon (Clithon) corona* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 39, figs. 45, 46.

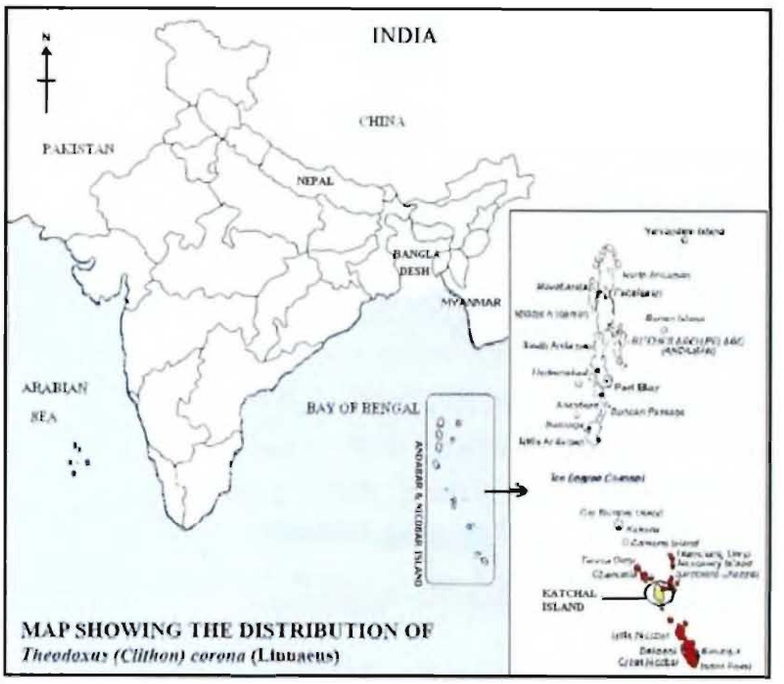
Fig. 33. A. Dorsal view of *Theodoxus (Clithon) corona* (Linnaeus)

Fig. 33. B. Ventral view of *Theodoxus (Clithon) corona* (Linnaeus)

Diagnosis : It is strongly polymorphic. A single population showing variation contained specimens with spires of varying heights and colouration. The shouldering of the body whorl and the development of spines are also variable. The spined and spineless forms are found occupying the same habitat.

Distribution : India : Nicobars (Katchal).

Elsewhere : Indonesia, Moluccas, Flores, Timor, New Guinea, New Ireland, New Caledonia



Remarks : Found in streams with moderate salinity.

Theodoxus (Clithon) reticularis (Sowerby, 1838)

1936. *Neritina retifera* Benson, *J. Asiat. Soc. Beng.*, **5** : 749, (Nomen nudum).

1838. *Neritina reticularis* : Sowerby, *Conch. Illustrations*, No. 51, fig. 44. Type locality : Calcutta.

1915. *Clithon reticularis* : Preston, *Fauna. Brit. India, Mollusca* (Freshwater Gastropoda and Pelecypoda) : 6.

Fig. 34. A. Dorsal view of *Theodoxus (Clithon) reticularis* (Sowerby)

Fig. 34. B. Ventral view of *Theodoxus (Clithon) reticularis* (Sowerby)

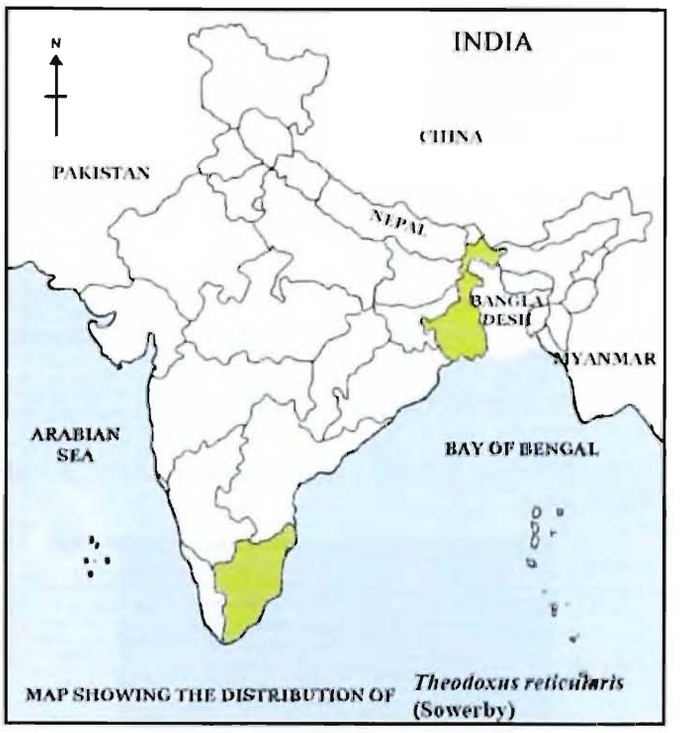
Type location : Not known.

Latest name and Reference : *Clithon reticularis* : Subba Raq, 1989, *Handbook of Freshwater Molluscs of India*, p. 40, figs. 32, 33.

Diagnosis : Shell finely striated, yellowish olive or green with oblique angulated red or black thin lines, often forming a coarse reticulation or network, a well developed tooth on the inner columellar margin.

Distribution : India : West Bengal, Tamil Nadu: Porto Novo.

Remarks : Found in estuarine water, rarely extending to the freshwater.



Family SEPTARIIDAE

Shell medium, symmetrical, limpet shaped, without whorls; apex small, aperture very wide; operculum squarish without apophyses and not closing the aperture.

Gill bipectinate, radula rhipidoglossate type. Right auricle absent. Sexes separate; males with cephali penis on the right side. Egg capsules are dehiscent, with two halves.

Found in freshwater of Indo-pacific region, rarely found in Africa. Only one Genus *Septaria* (includes *Navicella*) represented from India.

Genus ***Septaria*** Ferussac, 1807

1807. *Septaria* Ferussac, *Essai d'une meth. Conch.* : 61. Type species : *Patella borbonica* Bory de St. Vincent.

Shell medium, cap shape, with highly expanded last whorl. Operculum reduced to small quadrangular plate.

Widespread in the coastal freshwater streams near the zone of tidal influence of Indo-pacific region.

Two species recorded from India.

Key to the Species

1. Shell thin and transparent; apex not projecting beyond the posterior margin ..... *S. lineata* (Lamarck)

2. Shell thick and not transparent; apex projecting beyond the posterior margin ..... *S. porcellana* (Linnaeus)

Septaria lineata (Lamarck, 1816)

1816. *Navicella lineata* Lamarck, *Encycl. Meth. Vers. Expl. Planches,* : pl. 456, fig. 2.

1976. *Septaria lineata* : Starmuehlner, *Ann. Naturhist. Mus. Wien.*, **80** : 544.

Fig. 35. A. Dorsal view of *Septaria lineata* (Lamarck)

Fig. 35. B. Ventral view of *Septaria lineata* (Lamarck)

Fig. 36. A. Dorsal view of *Septaria dravidica* Prashad (Type)

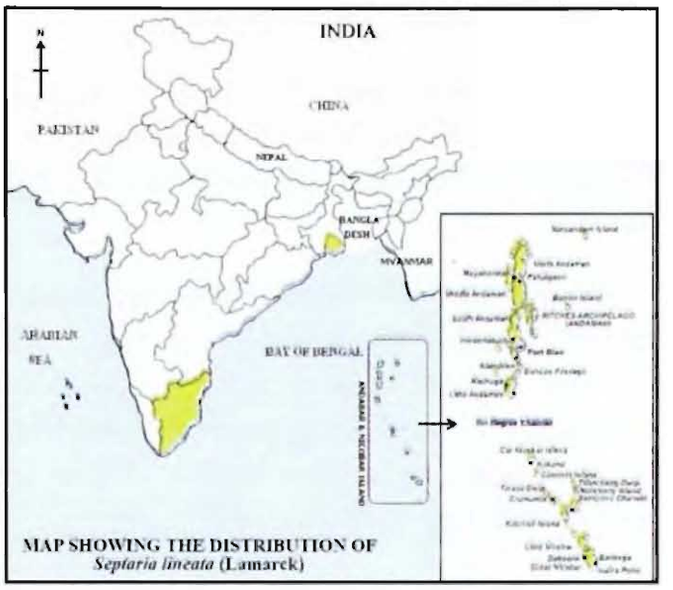
Fig. 36. B. Ventral view of *Septaria dravidica* Prashad (Type)

Type location : Museum D'Histoire Naturelle, Geneva.

Latest name and Reference : *Septaria lineata*: : Subba Rao 1989, *Handbook of Freshwater Molluscs of India*, p. 41, figs. 49, 50, 53, 54.

Diagnosis : Shell with various shapes depending on the nature of substratum. It shows considerable colour variations.

Distribution : India : Andaman and Nicobar Islands, Tamil Nadu (Coleron River), West Bengal : 24-Paraganas (South).



Elsewhere : Sri Lanka, Indonesia, Timor, Celebes, Moluccas, New Guinea, Fiji, Philippines.

Remarks : It is also found in saline water. Baker (1923) figured radula of this species. Andrew (1937) gave good description of the verge in male and ridge in female. Seshaiya (1934) described the style sac and Govindan and Natarajan (1972) studied the shell morphology, reproductive systems and breeding behaviour.

Septaria porcellana (Linnaeus, 1758)

1758. *Patella porcellana* Linnaeus, *Syst. Nat. ed.* **10** : 781. (Type locality : "O. Indiae).

1956. *Septaria porcellana* : Benthem Jutting, *Treubia*, **23** : 315, fig. 31.

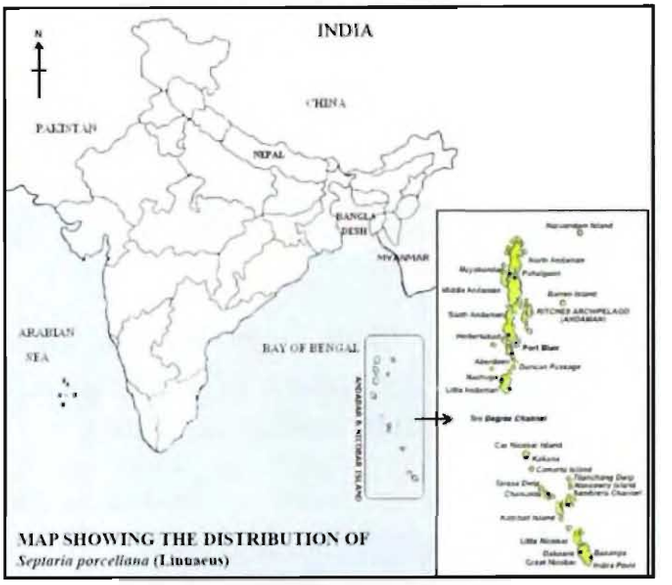
Fig. 37. A. Dorsal view of *Septaria porcellana* (Linnaeus)

Fig. 37. B. Ventral view of *Septaria porcellana* (Linnaeus)

Type location : Not known.

Latest name and Reference : *Septaria porcellana* : Subba Rao, 1989. *Handbook of Freshwater Molluscs of India*, p. 42, figs. 51, 52.

Diagnosis : The shell shows variation in colour pattern, the meshes of the colour network may be wide or narrow, sometimes coalescing or appearing as zigzag markings or triangular radiating marks. Some are found with egg capsules over them.



Distribution : India : Andaman and Nicobar Islands.

Elsewhere : Sri Lanka, Singapore, Indonesia, Celebes, Moluccas, New Guinea, New Caledonia, Samoa, Tahiti, Philippines.

Remarks : Occurs in freshwater streams.

Order MESOGASTROPODA
Superfamily VIVIPAROIDEA
Family VIVIPARIDAE

Shell moderately large, dextral, perforate or imperforate with a horny, corneous concentric operculum. Whorls rounded with or without bands, spire conical and aperture almost circular. Operculum horny, concentric. The central tooth is wide and lacks denticles. Females generally longer in size than the males.

Cosmopolitan. Found in freshwater throughout notably absent from South America.

The Viviparidae is limited to the freshwater in habiting streams, lakes, ponds, pools, marshes and wet rice field feeding on succulent vegetation. Respiration is strictly aquatic by bipectinate gill hanging into the right side of the mantle cavity. Right and left epipodial lobes are formed into spouts for the entrance and exist of respiratory current. Sexually dimorphic. Male with the right tentacle elongated to serve as a copulatory organ. Fertilisation internal. Pallial oviduct elongated acting as the uterus. The viviparous female carries developing young in the lower part of the oviduct. All the members are ovoviviparous, retaining 20 to 30 young ones in the uterus to the crawling stage. The uterus contains young at all times of the year but emits them into water only in summer.

This family was worked out by different authors on different aspects. Annandale (1921) discussed the systematic and the ornamentation of the shell. Prashad (1928) made a thorough study of shell, mantle and also distribution evolution and zoogeography of recent and fossil forms of the family Viviparidae. Some of other significant contributions are Annandale (1920, 1921, 1924), Haas (1939), Kobelt (1879, 1909), Reeve (1862, 1863) and Rohrbach (1937).

Vaught (1989) divided this family into three subfamilies Viviparinae, Bellamyinae and Campelominae. Out of these the first two subfamilies are represented from India.

Subfamily VIVIPARINAE

Shell generally olive brown or green, moderately large, turbiniform perforate or imperforate. Operculum horny, concentric with subcentral nucleus. Respiration entirely aquatic with the help of bipectinate gill. Head longer, eyes almost sessile. Sexually dimorphic forms. The viviparous female carries developing young in the lower part of oviduct.

This subfamily comprises of five genera, namely : *Viviparus*, *Margarya*, *Rivularia*, *Taia* and *Tulotoma*. Out of these the genus *Taia* is confined to Myanmar and North-eastern region of India.

Genus ***Taia*** Annandale, 1918

1918. *Thaia* Annandale, *Rec. Indian Mus.*, **14** : 123, 168. Type species : *Vivipara naticoides* Kobelt.

Shell thick, conical-ovate or conoidal or conical; sculpture with spiral striae or ridges with nodular or squamous tubercles and the body whorl with three of such ridges, three of primary ridges present on embryonic shell, the lower most well developed. Whorls 7 to 8, spire well developed. Aperture subtriangular, columellar callus broad and thick, extending over the umbilicus to form a convex ridge or flat plate. Operculum horny, pyriform, concave externally with strong ridge along the inner margin.

Head longer and eyes almost sessile; marginal teeth of radula very narrow; mantle edge muscular with highly contractile lobes correlating with shell aperture, and a broad lobe corresponding to the thickened columellar callus; Viviparus, embryos developed in uterus.

Found in the stream and ponds of North-eastern India and Myanmar. Annandale (1918) and Rao (1925) gave the detailed account of the genus *Taia*.

Only one species *Taia crassicallosa* Annandale and Rao found in Manipur and Tripura.

Taia crassicallosa Annandale and Rao, 1925

1925. *Taia crassicallosa* Annanmdale and Rao, *Rec. Indian Mus.*, **25** : 124, fig. 11-14. Type locality : Yawnghwe river near Tai-O, Yawnghwe state, South Shan states, Burma.

Fig. 38. A. Dorsal view of *Taia crassicallosa* Annandale and Rao

Fig. 38. B. Ventral view of *Taia crassicallosa* Annandale and Rao

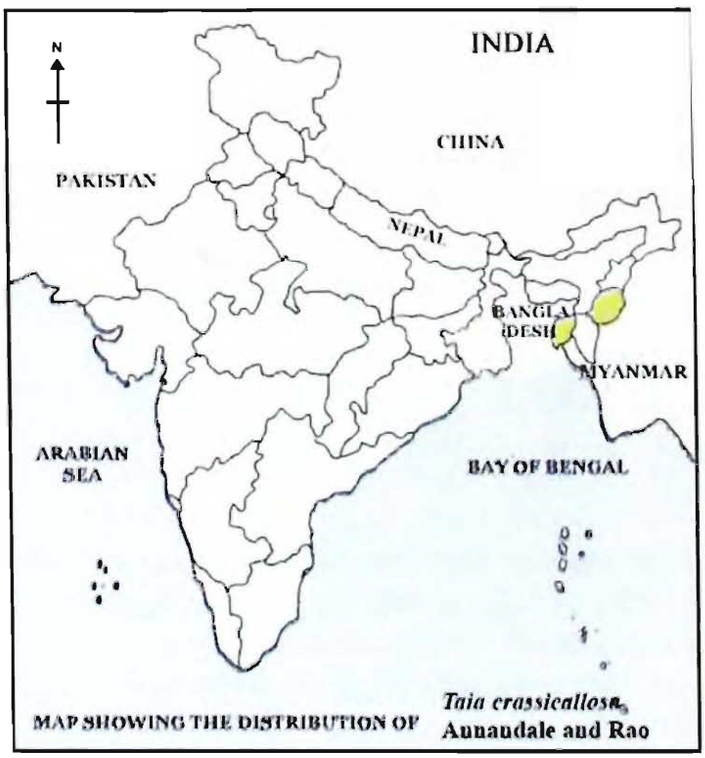
Type location : National Zoological Collection, ZSI, Regd. No. M 12462/2 (Holotype), M 12463/2 (Paratype).

Latest name and Reference : *Taia crassicallosa* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 53.

Diagnosis : Shell globose, spire relatively short and broad, never exceeding the height of the body whorl, ridges well developed, sometimes broken. Squamous tubercles, very prominent columellar callus greatly thickened.

Distribution : India : Manipur : Imphal, Jiribam, Bishenpur; Tripura.

Elsewhere : Myanmar.



Subfamily BELLAMYINAE

Shell medium to large, dextral, and varying in shape convex to angular or carinate, obtusely or strongly keeled at the periphery. Apex of the embryonic shell pointed, with ridges on the earliest whorls, which bears spiral rows of short bristle of periostracum. Aperture subcircular or broadly ovate; operculum corneus, concentric. Shell unbanded in the embryonic stages.

Respiration with monopectinate ctenedium or gill. Sexually dimorphic. Male with a big bean shaped complex testis on the right side of the roof of the mantle cavity. Female with complex seminal receptacle.

Prashad (1928) made revisionary studies and Rao (1925) made the anatomical studies of this subfamily. Represented by twelve genera out of which three genera namely, *Bellamya*, *Angulyagra* and *Cipangopaludina* are represented from Indian waters.

Key to the Genera

1. Shell smooth, without distinct ridges or sculpture ..... (2)

– Shell ornamented with a number of well developed spiral ridges, continuous or broken up into nodular or squamous tubercles ..... *Angulyagra* Rao

2. Shell medium, with coloured bands: edge of the mantle not thickened, without a conspicuous sphincter; superior margin of gill lamella never thrown into folds; embryonic shell with three primary ridges bearing chaetae and a number of secondary ridges ..... *Bellamya* Jousseaume

– Shell large, without any coloured bands; edge of mantle thickened, with a conspicuous sphincter muscle along it; superior margin of gill lamella usually thrown into folds; embryonic shell with three ridges bearing curved chaetae ..... *Cipangopaludina* Hannibal

Genus ***Bellamya*** Jousseaume, 1886

1886. *Bellamya* Joussaeume, *Bull. Soc. Zool. France,* **11** : 478. Type species : *Vivipara duponti* De Rochebrune, 1882

Shell medium, more or less oblong, obtusely or strongly keeled at the periphery, scarcely convex or rather flattened whorls. Columellar margin thinner. Apex of the embryonic shell pointed, with a ridge on the earliest whorls, which bear spiral rows of short bristles of periostracum.

Head small, margin of the mantle moderately thick with three short processes corresponding in position. Young ones leaves the mother at the stage of about three whorls.

Occurs in lakes, ponds, ditches, rivers, slowly flowing streams or any other type of freshwater bodies even those which regularly become dry

Bellamya is distinguished from *Viviparus* of Europe by anatomical characters; it differs in the position of testis (Rohrbach, 1937). *Bellamya* is present in Southern Asia and Africa.

Bellamya bengalensis the common banded pond snail of India was described by Annandale (1921), Annandale and Sewell (1921) and also by Sewell (1921) who dealt with the ecology and growth rate. It breeds throughout the year reaching its peak during April to July and dealt with detritus feeder.

Key to the species

1. Shell with dark colour bands ..... (2)

– Shell without any colour bands ..... (3)

2. Spire acuminate, body whorl convex in profile, without delicate ridge ..... *B. bengalensis* (Lamarck)

– Spire bluntly acuminate, body whorl transverse and oblique, with delicate ridge .... *B. crassispiralis* (Annandale)

3. Shell globose, spire small and blunt, suture deeply impressed ... *B. crassa* (Benson)

– Shell ovately conical, spire high, suture not deeply impressed ..... *B. dissimilis* (Mueller)

Bellamya bengalensis (Lamarck, 1822)

1822. *Paludina bengalensis* Lamarck, *Hist. nat. Anim. Sans. Vert.* **6**(2) : 174.

1921. *Vivipara bengalensis* : Annandale, *Rec. Indian Mus.*, **22** : 267.

Type location : Museum D'Histoire Naturelle, Geneva.

Latest name and Reference : *Bellamya bengalensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 45.

Diagnosis : Shell thin, more or less smooth, with three or more colour bands, embryonic shell delicate and thin, with three primary rows of chaetae, low ridges, the lower most well developed, sometimes developing into a keel, secondary ridges bearing chaetae may develop between the primary ones.

Distribution : India : Common throughout.

Elsewhere : Myanmar; Bangladesh; Sri Lanka.

Remarks : Annandale (1921) studied the systematic of this species and recognized the 22 forms mainly based on the shell characters, the radula and soft parts being strikingly uniform. He also remarked that these differences are mainly due to the physical factors of environment rather than the geographical isolation of the race. Sewell (1922) discussed the anatomy and bionomics of this species.

Though a few larval trematodes were recorded from this species it is not considered to be a significant intermediate host.

Based on shell characters, principally on the form of spire, a good number of intraspecific forms were described.

form ***typica*** (Lamarck)

Type location : Museum D'Histoire Naturelle, Geneva.

Latest name and Reference : *Bellamya bengalensis f. typica* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series,* **5**(Part-5), p. 188. *Zool. Surv. India.*

Fig. 39. A. Dorsal view of *Bellamya bengalensis* form *typica* (Lamarck)

Fig. 39. B. Ventral view of *Bellamya bengalensis* form *typica* (Lamarck)

Diagnosis : Shell thin, spire and body whorl of almost equal height, whorls gradually increasing, less rounded and with rather straight sides, sutures shallow; aperture sub circular with a narrow black margin. Bands are variable and irregular, alternating broad and narrow bands.

Distribution : India : Throughout.

Elsewhere : Myanmar.

Remarks : Although it is a common freshwater mollusc of India, it is not an important intermediate host for parasites.

form ***annandalei*** (Kobelt, 1908)

1908. *Vivipara annandalei* Kobelt, *Malak. Ges.*, **60** : 161. (Type locality : Visakhapatnam, Andhra Pradesh).

Fig. 40. A. Dorsal view of *Bellamya bengalensis* form *annandalei* (Kobelt)

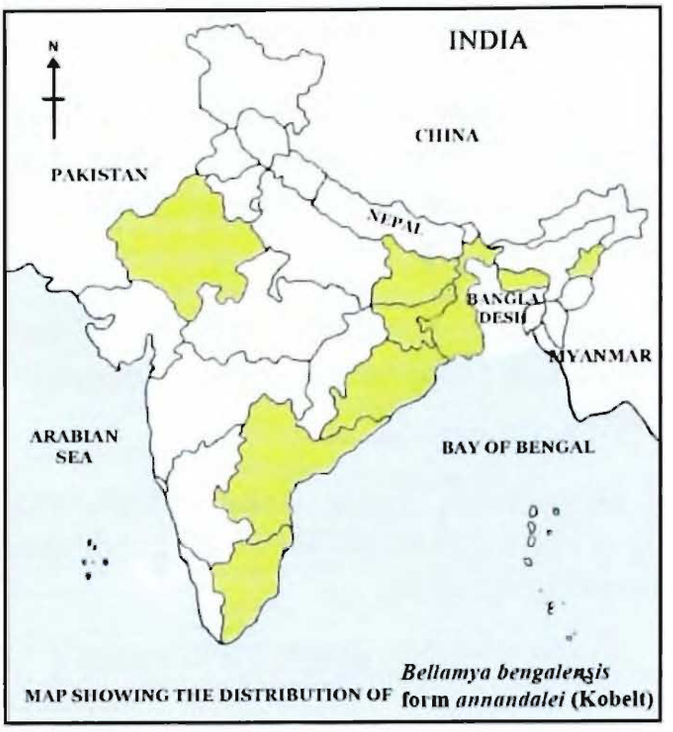
Fig. 40. B. Ventral view of *Bellamya bengalensis* form *annandalei* (Kobelt)

Type location : Not known

Latest name and Reference : *Bellamya bengalensis* f. *annandalei* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series,* 5(Part-5), p. 188. *Zool. Surv. India.*

Diagnosis : Shell thinner, whorls gradually increasing, less rounded and with rather straight sides, sutures shallow.

Distribution : India : Andhra Pradesh, Bihar, Jharkhand: Santhal Paragana; Manipur: Imphal, Jiribam, Bishenpur, Meghalaya: Garo Hills (East & West), Khasi Hills (East), Jaintia Hills; Orissa, Rajasthan, Tamil Nadu, West Bengal.



MAP SHOWING THE DISTRIBUTION OF *Bellamya bengalensis* form *annandalei* (Kobelt)

form ***balteata*** (Benson)

1836. *Viviparus bengalensis* var. *balteata* Benson, *J. asiat. Soc. Beng.* Pt. **2** : 745. (Type Locality : Silcuri, Cachar, Assam.

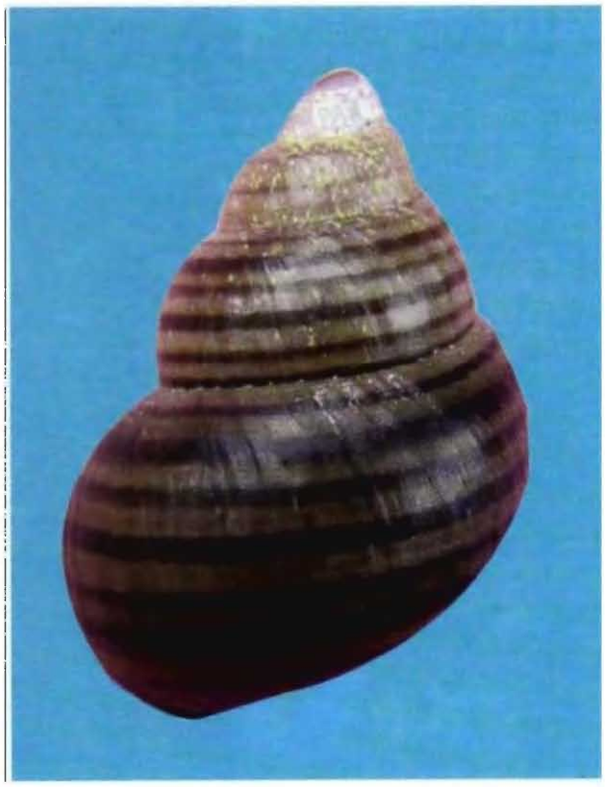


Fig. 41. A. Dorsal view of *Bellamya bengalensis* form *balteata* (Benson)

Fig. 41. B. Ventral view of *Bellamya bengalensis* form *balteata* (Benson)

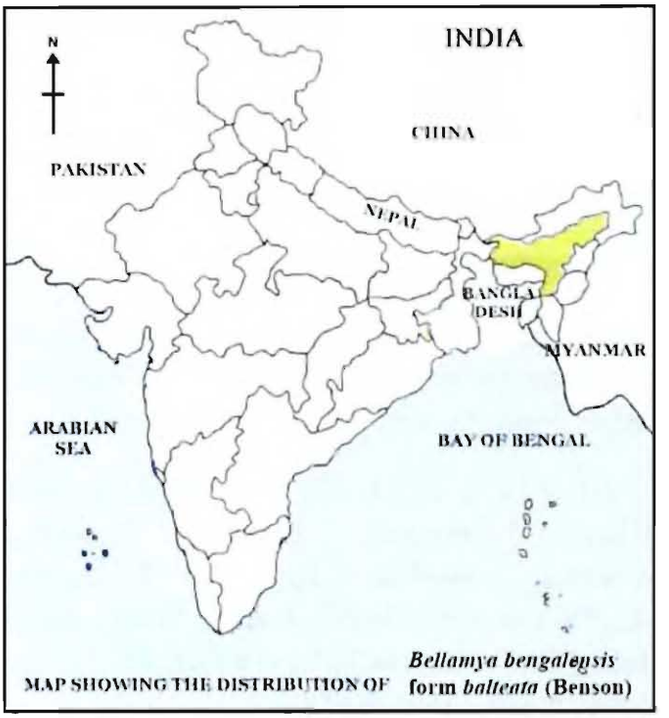
Type location : Not known.

Latest name and Reference : *Bellamya bengalensis* form *balteata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 46, fig. 63.

Diagnosis : Shell narrow, whorls contracted, aperture ovoid, umbilicus closed.

Distribution : India : Assam, Meghalaya : Garo Hills (South & West), Ri-Bhoi; West Bengal : Darjeeling.

Elsewhere : Bangladesh.



form ***colairensis*** (Annandale, 1921)

1921. *Viviparus bengalensis* var. *colairensis* Annandale, in *Rec. Indian Mus.*, **22** : 275, pl. 1, figs. 5, 6. (Type locality : Sriparptipada, Colair Lake, Andhra Pradesh).

Fig. 42. A. Dorsal view of *Bellamya bengalensis* form *colairensis* (Annandale)

Fig. 42. B. Ventral view of *Bellamya bengalensis* form *colairensis* (Annandale)

Type location : National Zoological Collection, ZSI, Regd. No. M 11691/2 (Holotype), M 25075/5 (Paratypes).

Latest name and Reference : *Bellamya bengalensis* f. *colairensis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series,* **5**(Part-5), p. 189. *Zool. Surv. India.*

Diagnosis : Shell thin, elongate, translucent; aperture relatively small, almost circular; shell with deep and dull in colour.

Distribution : Restricted to type locality.

race ***doliaris*** (Gould, 1843)

1843. *Paludina doliaris* Gould, *Proc. Boston Soc. nat. Hist.*, **1** : 144. (Type locality : Burma).

1989. *Bellamya bengalensis* form *doliaris* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 46.

Fig. 43. A. Dorsal view of *Bellamya bengalensis* race *doliaris* (Gould, 1843)

Fig. 43. B. Ventral view of *Bellamya bengalensis* race *doliaris* (Gould, 1843)

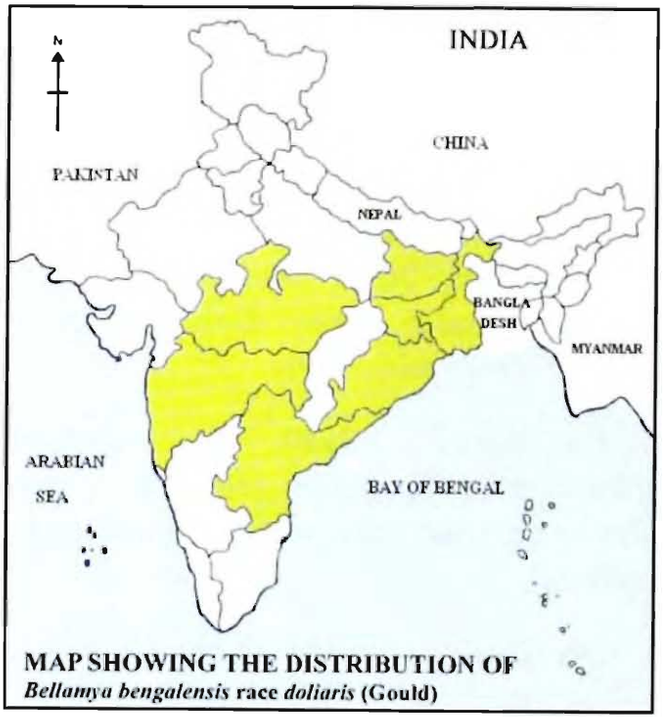
Type location : Not known.

Latest name and Reference : *Bellamya bengalensis* f. *doliaris* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series,* **5**(Part-5), p. 189. *Zool. Surv. India.*

Diagnosis : Shell smaller and more conical, last whorl distinctly biangulate.

Distribution : India : Andhra Pradesh: Annantpur, Kurnool; Bihar, Jharkhand : Santhal Paragana; Madhya Pradesh, Maharashtra, Orissa, West Bengal : 24 Paraganas (North & South), Birbhum, Hugli, Murshidabad, Puruliya.

Elsewhere : Myanmar.



form ***eburnea*** (Annandale)

1921. *Viviparus bengalensis* race *eburnea* Anandale, *Rec. Indian Mus.*, **22** : 274, pl. 2, figs. 1-2. (Type locality : Kaligiri (= Kanigiri) reservoir, Nellore, Andhra Pradesh).

1989. *Bellamya bengalensis* form *eburnea* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 47, fig. 59.

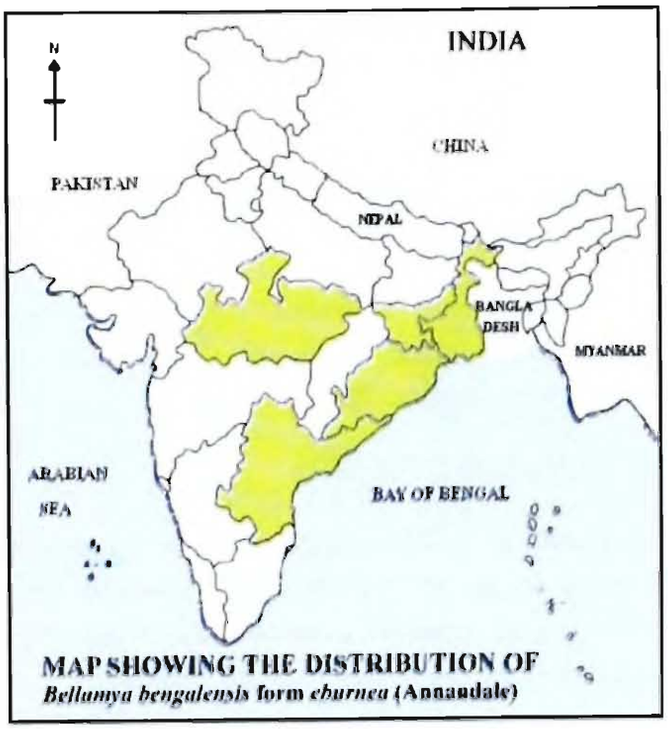
Fig. 44. A. Dorsal view of *Bellamya bengalensis* form *eburnea* (Annandale)

Fig. 44. B. Ventral view of *Bellamya bengalensis* form *eburnea* (Annandale)

Type location : National Zoological Collection, ZSI, Regd. No. M11960/ 2(Syntypes).

Latest name and Reference : *Bellamya bengalensis* f. *eburnea* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series,* 5(Part-5), p. 190. *Zool. Surv. India.*

Diagnosis : Shell narrow with smaller aperture, whorls much less inflated with distinct flattening below the sutures; body whorl showing a tendency to become biangulate.



Distribution : India : Andhra Pradesh: Hyderabad, Krishna, Nellore; Jharkhand, Madhya Pradesh, Orissa, Tamil Nadu, West Bengal : S. 24 Paraganas, Hugli, Puruliya.

form ***gigantea*** (Reeve)

1862. *Paludina gigantea* (von dem Bush MSS) Reeve, *Conch. Icon.*, **14** : *Paludina*, pl. 12, fig. 7.

Fig. 45. A. Dorsal view of *Bellamya bengalensis* form *gigantea* (Reeve)

Fig. 45. B. Ventral view of *Bellamya bengalensis* form *gigantea* (Reeve)

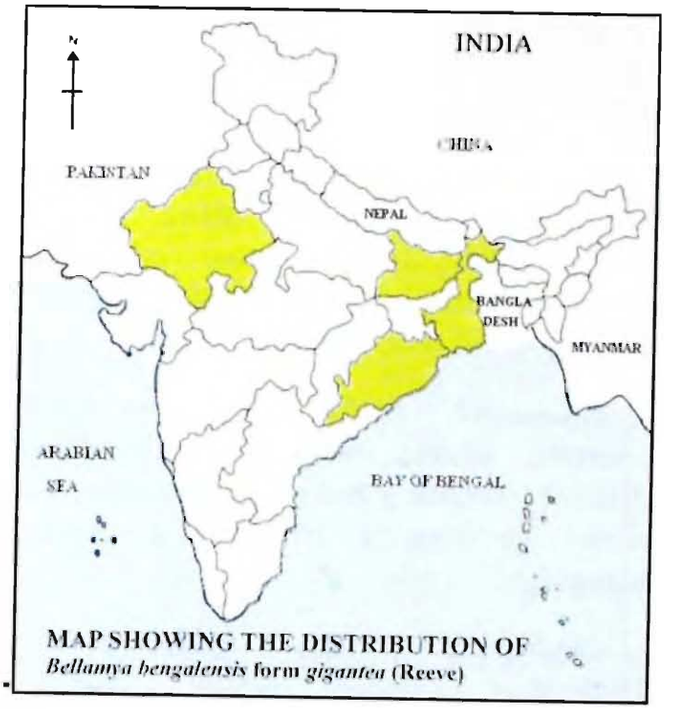
Type location : Not known.

Latest name and Reference : *Bellamya bengalensis* race *gigantea* : Mitra and Dey, 1992, *Fauna of West Bengal, State Fauna Series,* **3**(Part-9), p. 13. *Zool. Surv. India.*

Distribution : India : Bihar, Orissa, Rajasthan, West Bengal : South 24-Paraganas, Nadia, Bardhaman;

Elsewhere : Pakistan.

Remarks : Most of the shells examined appear to be young, but with typical large, subcircular aperture, wide umbilicus, deep sutures and prominent spiral bands.



phase ***halophila*** (Kobelt)

1908. *Vivipara annandalei* var. *halophila* Kobelt. In : Martini-Chemnitz, *Syst. Conch. Cab.*, **1**(21/2) : 297, pl. 59, figs 17-20. Type Locality : Salt Range, Punjab.

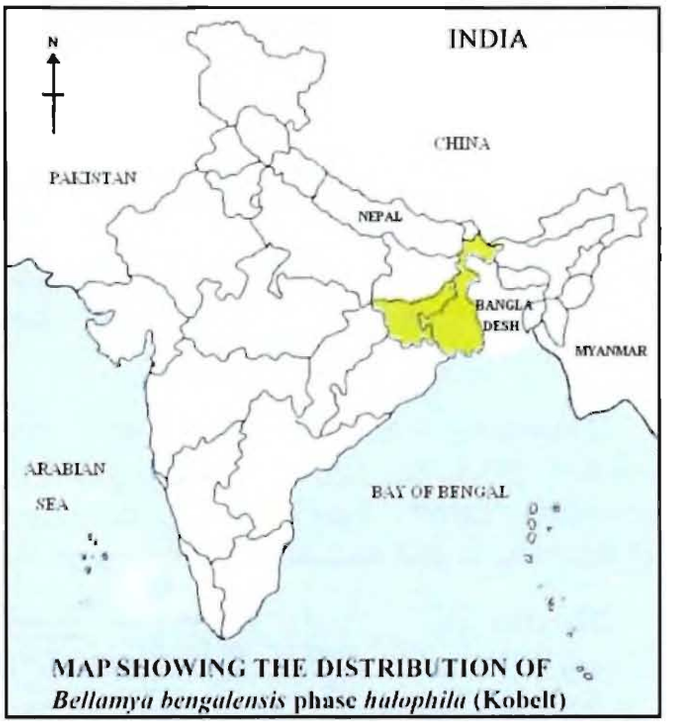
Fig. 46. A. Dorsal view of *Bellamya bengalensis* phase *halophila* (Kobelt)

Fig. 46. B. Ventral view of *Bellamya bengalensis* phase *halophila* (Kobelt)

Type location : National Zoological Collection, ZSI, Regd. No. M 5078/1 (Syntypes).

Diagnosis : Shell narrow, whorls contracted, aperture ovoid, umbilicus closed.

Distribution : India : Jharkhand : Santhal Paragana (Ray, 1943); West Bengal : Kolkata, Bardhaman.



form ***mandiensis*** (Kobelt, 1909)

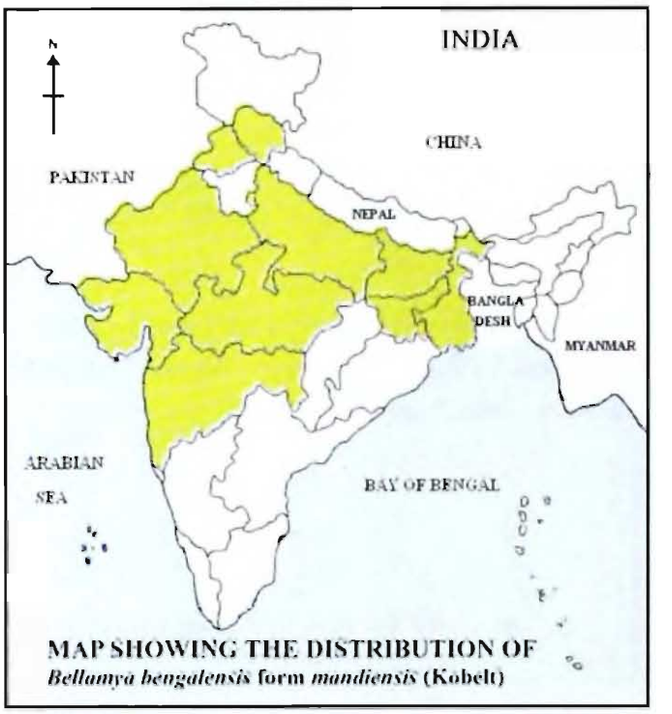
1909. *Viviparus bengalensis* var. *mandiensis* Kobelt, in Martini Chemnitz, *Conch. Cab.*, **2** : 414, pl. 77, figs. 8-9. (Type locality : Mandi Kangra, Himachal Pradesh).

Fig. 47. A. Dorsal view of *Bellamya bengalensis* form *mandiensis* (Kobelt)

Fig. 47. B. Ventral view of *Bellamya bengalensis* form *mandiensis* (Kobelt)

Type location : National Zoological Collection, ZSI, Regd. No. M 5081/1 (Holotype).

Latest name and reference : *Bellamya bengalensis* form *mandiensis* : Mitra and Dey, 1992, *Fauna of West Bengal, State Fauna Series,* 3(Part-9), p. 14. *Zool. Surv. India.*



Diagnosis : Shell narrower and more conical than in form *typica,* umbilicus broader; spiral bands well developed alternating broad and narrow bands.

Distribution : India : Bihar, Delhi, Gujarat, Himachal Pradesh (Renuka), Jharkhand: Santhal Paragana; Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Uttar Pradesh, West Bengal : North 24 Paraganas, Hugli, Midnapore, Nadia.

Elsewhere : Myanmar, Bangladesh, Sri Lanka,

Remarks : This form is very much resembles with form *anandalei*, but differs in being thinner, paler and more conical in shape with a proportionately broader last whorl.

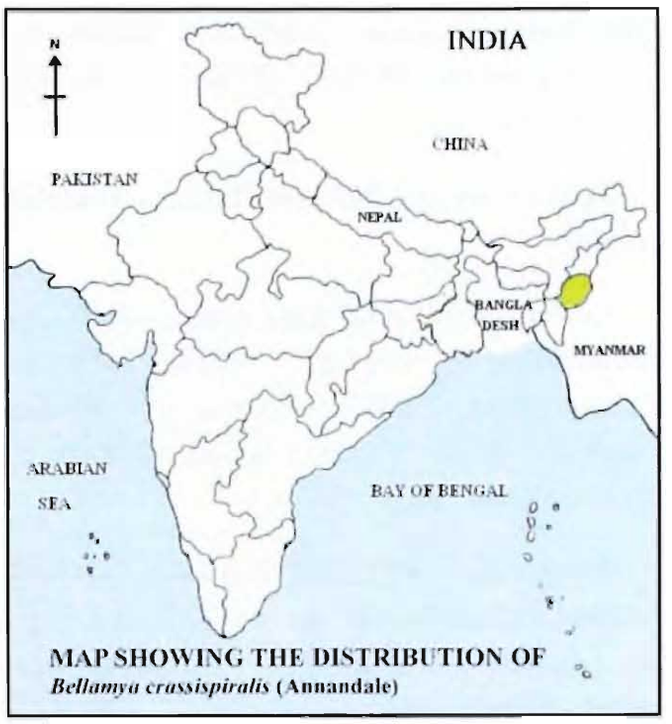
Bellamya crassispiralis (Annandale, 1921)

1921. *Vivipara crassispiralis* Annandale, *Rec. Indian Mus.* **22** : 544, pl. iv, fig.1, (Type locality : Chakpi stream in the South of Manipur Valley near the Burmese Frontier.

Fig. 48. A. Dorsal view of *Bellamya crassispiralis* (Annandale)

Fig. 48. B. Ventral view of *Bellamya crassispiralis* (Annandale)

1989. ***Bellamya crassispiralis*** : Subba Rao, *Handbook of Freshwater Molluscs of India* : 47, fig. 68.



Type location : National Zoological Collection, ZSI, Regd. No. M 11738/2 (Holotype).

Latest name and Reference : *Bellamya crassispiralis*: Surya Rao, Kukherjee : Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 74. *Zool. Surv. India.*

Diagnosis : Shell ovate conical, bluntly acuminate, whorls tumid, body whorl tranverse and oblique, anterior margin strongly sinuate, with six rather delicate ridges, aperture small, suboval, evenly rounded below and obliquely and bluntly pointed above, outerlip thin, evenly and broadly arched columella, slightly laminated and retroverted umbilicus rimately perforate.

Distribution : Manipur Valley (Known by type).

Bellamya crassa (Benson, 1836)

1836. *Paludina crassa* (Hutton Ms) Benson, *J. Asiat. Soc. Beng.*, **5** : 745. (Type locality : River Gomati, Jaunpur, Uttar Pradesh).

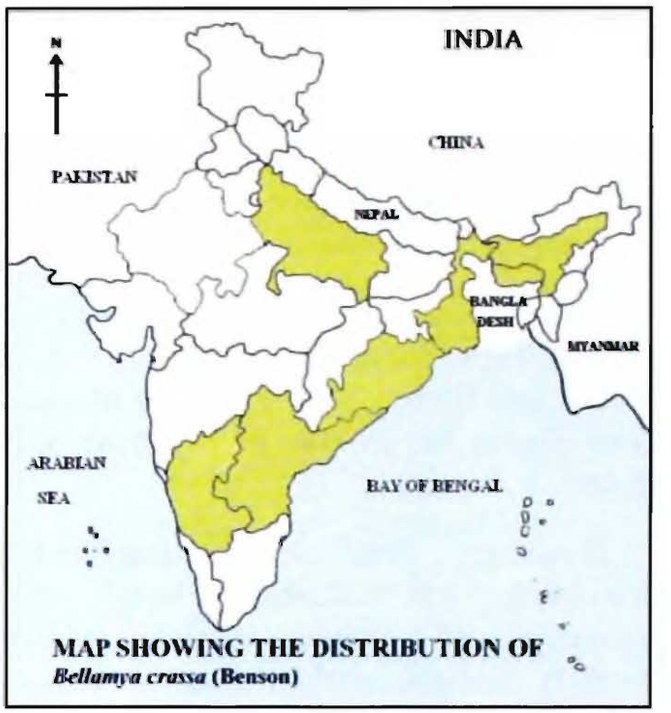
Fig. 49. A. Dorsal view of *Bellamya crassa* (Benson)

Fig. 49. B. Ventral view of *Bellamya crassa* (Benson)

1989. *Bellamya crassa* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 48, figs., 60-61.

Type location : Natural History, Museum, London.

Latest name and Reference : *Bellamya bengalensis* f. *crassa* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part 5), p. 190. *Zool. Surv. India.*



Diagnosis : Shell olive brown, globose, without colour bands, spire small and blunt, shell surface sculptured with fine wavy spiral lines; aperture suboval, columella arched, anterior margin almost straight, outerlip arched, umbilicus rimately perforate.

This species is reported to be burrowing in mud or sand in shallow waters, often in groups even in favourable condition (Preston, 1915).

Distribution : India : Andhra Pradesh : Kurnool; Assam; Cachar; Karnataka; Meghalaya : Garo Hills (West), Jaintia Hills; Orissa; Uttar Pradesh : River Gomati, Jaunpur; Gujarat; West Bengal : Nadia: Ranaghat, Malda, Jalpaiguri : Siliguri.

Elsewhere : Bangladesh : Hazrapur, Sylhet.

Bellamya dissimilis (Mueller, 1774)

1774. *Nerita dissimilis* Mueller, *Hist. Verm. Test.*, pt. 2 : 184. Type locality : Not mentioned.

Fig. 50. A. Dorsal view of *Bellamya dissimilis* (Mueller)

Fig. 50. B. Ventral view of *Bellamya dissimilis* (Mueller)

1862. *Paludina variata* : Frauenfeld, *Verhandl, Zool. bot. Ges. Wien.*, : 1163, (Type locality : Pondicherry).

1989. *Bellamya dissimilis* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 48. figs. 64-67.

Type location : Copenhagen Museum.

Latest name and Reference : *Bellamya dissimilis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part 5), p. 190. *Zool. Surv. India.*

Diagnosis : Shell small, high and narrow, spire swollen, suture deeply impressed, without dark spiral bands, body whorl with one slightly elevated ridge or broad and obscure, pale spiral band. Rim of the aperture often black, operculum thicker and muscular scar better developed. Edge of the mantle smooth in the adult.

Distribution : Common throughout India.

Elsewhere : Bangladesh; Malayasia; Myanmar; Pakistan; Sri Lanka.

Bellamya micron (Annandale, 1921)

1921. *Vivipara micron* Annandale, *Rec. Indian Mus.*, **22** : 550, fig. 5, (Type locality : Manipur).

Fig. 51. A. Dorsal view of *Bellamya micron* (Annandale)

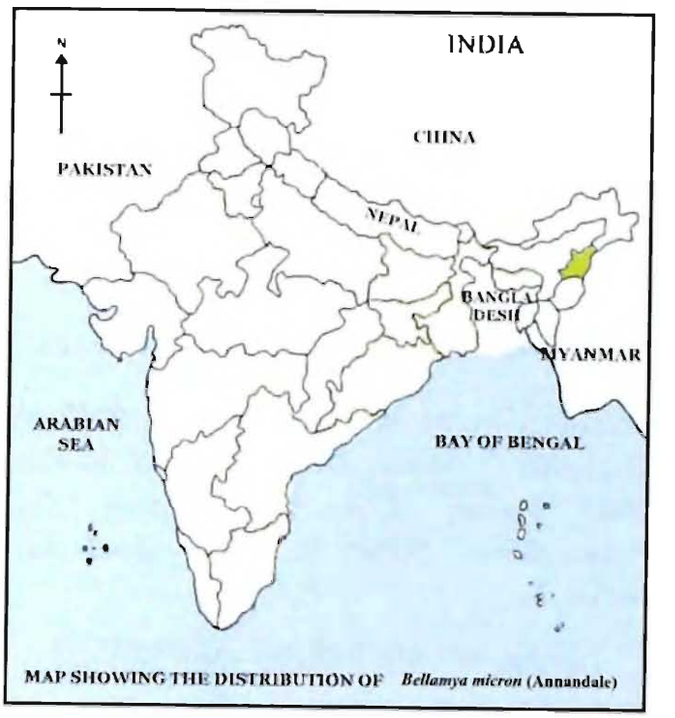
Fig. 51. B. Ventral view of *Bellamya micron* (Annandale)

1989. *Bellamya micron* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 49, figs. 71-72.

Type location : National Zoological Collection, Zoological Survey of India, Regd. No. M 11855/2 (Holotype).

Latest name and Reference : *Bellamya micron* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 75. *Zool. Surv. India.*

Diagnosis : Shell rather thin, small, nearly transparent, perforate, ovately conical, finely, minutely striate; whorls 5, rounded, sutures impressed, aperture suboval, outer lip thin.



MAP SHOWING THE DISTRIBUTION OF *Bellamya micron* (Annandale)

Distribution : Manipur. Known by type only.

Genus ***Angulyagra*** Rao, 1931

1931. *Angulyagra* Rao, *Rec. Indian Mus.*, **33** : 301. Type species : *Paludina oxytropis* Benson.

Shell large, thin, conical with prominent smooth and hollow spiral ridges on the surface, uniformly coloured with darker on the ridges. Embryonic shell elongated with a well developed peripheral keel, umbilicus broadly rimate with a broad channel descending downward.

India (North-eastern states), China, Japan, Java, Malay Penninsula, Myanmar, Philippines.

Two species *A. microchaetophora* (Annandale) and *A. oxytropis* (Benson) reported from North-eastern states of India.

Key to the Species

1. Body whorl without any definite spiral ridges except the peripheral keel .... *A. microchaetophora* (Annandale)

2. Body whorl with three distinct ridges and three less prominent ridges below the peripheral keel .....*A. oxytropis* (Benson)

Angulyagra microchaetophora (Annandale, 1921)

1921. *Vivipara microchaetophora* Annandale, *Rec. Indian Mus.*, **22** : 546, fig.4. Type locality : Dimapur, Nagaland.

1989. *Angulyagra microchaetophora* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 51, fig. 69.

Fig. 52. A. Dorsal view of *Angulyagra microchaetophora* (Annandale)

Fig. 52. B. Ventral view of *Angulyagra microchaetophora* (Annandale)

Fig. 53. A. External view of operculum *Angulyagra microchaetophora* (Annandale)

Fig. 53. B. Internal view of operculum *Angulyagra microchaetophora* (Annandale)

Type location : National Zoological Collection, ZSI, Regd. No. M 11856/2.

Latest name and Reference : *Angulyagra microchaetophora* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 73, *Zool. Surv. India.*

Diagnosis : Shell small, thin, imperforate, sharply acuminate, a blunt peripheral ridge on the body whorl, columella strongly arched, outerlip sharp, spiral whorls with two fine spiral ridges.

Occurs in ponds on floating grass stems and longer part of plant that float on the water surface.

MAP SHOWING THE DISTRIBUTION OF *Angulygra microchaetophora* (Annandale)

Distribution : India : Nagaland, Assam, Manipur : Imphal.

Angulyagra oxytropis (Benson, 1836)

1836. *Paludina oxytropis* Benson, *J. Asiat. Soc. Beng.*, **5** : 545.

1921. *Vivipara oxytropis* : Annandale, *Rec. Indian Mus.*, **22** : 548, pl. 4, figs. 2-5.

1989. *Angulyagra oxytropis* : Subba. Rao, *Handbook of Freshwater Molluscs of India*, p. 51, fig. 70.

Fig. 54. A. Dorsal view of *Angulyagra oxytropis* (Benson)

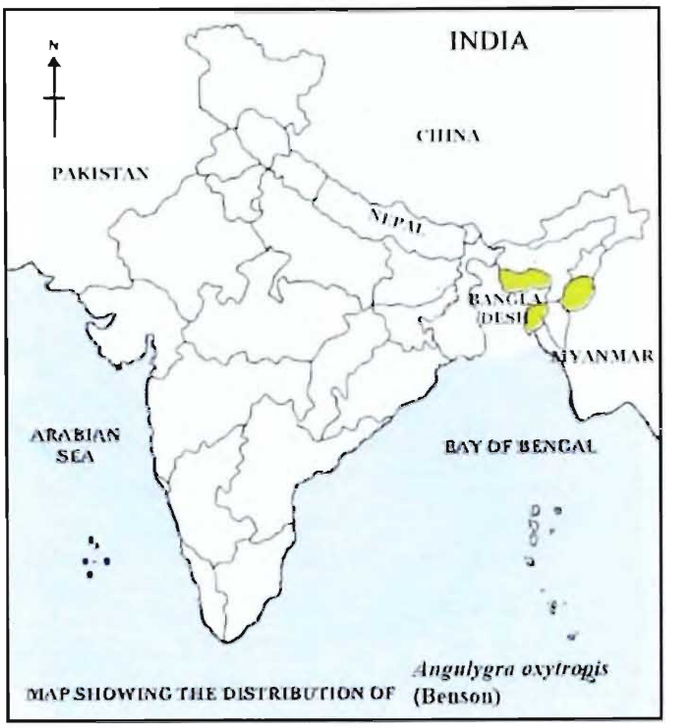
Fig. 54. B. Ventral view of *Angulyagra oxytropis* (Benson)

Type location : Not known.

Latest name and Reference : *Angulyagra oxytropis* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 73. *Zool. Surv. India.*

Diagnosis : Shell large, acuminate, broadly conical, narrowly perforate, prominent spiral ridges, outerlip thin but not sharp, broadly and regularly arched, with a distinct prominence at the termination of the peripheral ridge, spiral whorls with two smooth prominent spiral ridges.

The female can be distinguished from the male having a distinct broader on the shell. Females are more abundant than the males (Annandale, 1921).



MAP SHOWING THE DISTRIBUTION OF

Distribution : India : Manipur Valley, Meghalaya, Tripura (South).

Genus ***Cipangopaludina*** Hannibal, 1912

1912. *Cipangopaludina* Hannibal, *Proc. malac. Soc. Lond.*, **10** : 194. Type Species : *Paludina malleata* Reeve.

1920. *Lecythoconcha* : Annandale, *Rec. Indian Mus.*, **20** : 114. Type Species : *Paludina lecythis* Benson.

Shell large, smooth, uniformly coloured, without bands with broad swollen whorls. Embryonic shell with 3 ridges bearing curved chaetae. Aperture large, sub circular or broadly ovate, columellar fold weakly developed, umbilicus narrowly perforate. Operculum with prominent concentric ridges and a deep funnel shaped subcentral pit externally and also a corresponding smooth rounded boss internally. Free mantle edge thickened and muscular, three marginal processes in the young ones.

India (North-eastern states), Asiatic Russia, China, Japan, Java, Korea, Myanmar, Thailand, Vietnam.

Only one species reported from North-eastern states.

Cipangopaludina lecythis (Benson, 1836)

1836. *Paludina lecythis* Benson, *J. Asiat. Soc. Beng.*, **5** : 745, (Type locality : Manipur).

1921. *Lecythoconcha lecythis* : Annandale, *Rec. Indian Mus.*, **22** : 553, pl. v. figs. 1-4., pl. vi. figs. 1, 2.

Fig. 55. A. Dorsal view of *Cipangopaludina lecythis* (Benson)

Fig. 55. B. Ventral view of *Cipangopaludina lecythis* (Benson)

1989. *Cipangopaludina lecythys* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 50, fig. 73.

Type location : National Zoological Collection, ZSI, Regd. No. 2300 (Holotype).

Latest name and Reference : *Cipangopaludina lecythis* : Surya Rao, Kukherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 75. *Zool. Surv. India.*

Diagnosis : Shell olive green when fresh, spire conical, apex acuminate, whorls tumid and flattened above, suture deep, aperture large and broadly oval, outer lip sharp and tinged with black, columella arched.

Distribution : India : Manipur: Churachandpur, Chandel, Bishenpur, Imphal, Thoubal; Meghalaya : Ri-Bhoi; Mizoram, Tripura (South and West).

Elsewhere : Myanmar; Southern Shan States; Yunnan and Vietnam.

Remarks : The holotype bearing the Reg. No. 2300 is labelled as being from Sylhet. Annandale (1921) remarked that the type

locality "Sylhet" may be a mistake, it may be from Loktak Lake, Manipur, as this shell very much agree with the shells from Loktak Lake having Reg. No. 2301.

Family AMPULLARIIDAE

Shell medium to large, perforate or imperforate, dextral or sinistral; depressed to ovate, with rounded angular or carinate whorls. Shell green or olive brown in colour. Operculum large, concentric, calcareous or corneous with a sub central nucleus.

Animals with tentacle like process (pseudopodium) on each side of the snout in addition to a pair of filiform tentacles. Near each is an epipodial lobe, the left one forming an inhalant siphon and the right one an exhalant siphon. The mantle cavity bears a long monopectinate gill on each side and is modified into pulmonary sac on either side. Central tooth broad and lacking basal denticles. Sexes are separate, female oviparous; male with a copulatory organ on the right side, formed by modified part of the mantle border which encloses the penis. Amphibious in habit. Common in freshwater ponds, tanks, streams and paddy fields. Some species lives in seasonal water bodies which dry out for a long period. Distributed in tropical region of America, Asia and Africa. Prashad (1925) revised the Indian Pilidae. The anatomy of mantle cavity, kidney, gut, blood-vascular system and reproductive system were studied by Andrew (1964, 1965) and Pain (1972).

Commonly known as apple snail and represented by a single genus, *Pila*, throughout India. It has a subgenus *Turbinicola* found in the streams with restricted distribution.

The family Ampullaridae (Pilidae) is amphibious inhabitants of freshwater in warmer countries. They can respire both underwater and in air by gill and pulmonary sac. They can able to make long excursion on land. *Pila globosa* the common Indian apple snail has been studied by (Ramanan 1903, Prashad 1925, 1928, Bahl 1928). With the on set of rains this snail goes to the banks of pond or stream, excavates a depression in which it deposits a gelatinous mass of 200-300 eggs and protects this mass in folds of the mantle and foot until a calcareous shell has formed around each egg.

Genus ***Pila*** **(Bolten)** Roeding, 1798

1798. *Pila* (Bolten) Roeding, *Mus. Bolten.*, pt. 2 : 145 (in part). Type species : *Helix ampullacea* Subsequent designation, Dall, 1904.

Medium to very large dextral, globose, with convex non angular whorls. Aperture large expanded, body whorl inflated, umbilicus open or closed; operculum with an inner calcareous layer. Radula: lateral teeth with 5 cusps, central one the largest and innermost reduced. Cluster of eggs with brittle calcareous shell are deposited above the water. Found in Asia, Africa, Australia and Indo-Pacific Islands (Brandt, 1974).

Pila has unique respiratory provision that enables it to respire equally well under water and in air (Robson 1922, Prashad 1925). In the submerged condition the respiratory current enters on the left side by way of the large left nuchal lobe rolled into a funnel, by passes the closed pulmonary sac, continues obliquely to the posterior end of the mantle cavity.

Prashad (1925) revised this genus and reported 8 species and 6 varieties from India, Sri Lanka and Myanmar. 5 species namely *Pila globosa* (Swainson), *Pila scutata* (Mousson), *Pila theobaldi* (Hanley), *Pila virens* (Lamarck), *Pila (Turbinicola) saxea* (Reeve) reported from Indian water.

Asia and Africa.

Key to the Species

1. Shell globose and spacious, upper surface of whorls obliquely flattened, suture not deep, spire depressed ..... *P. globosa* (Swainson)

– Shell ovoid or semiglobose, suture deeply impressed, spire elevated ..... (2)

2. Suture canaliculate with distinct carination; spire prominent and conical ..... *P. virens* (Lamarck)

– Suture without distinct carination; spire distinct and elongated ..... (4)

3. Shell larger, whorls globose; umbilicus widely open ..... *Pila theobaldi* (Hanley)

– Shell smaller, whorls descending step like, umbilicus nerrowly open ..... *Pila scutata* (Mousson)

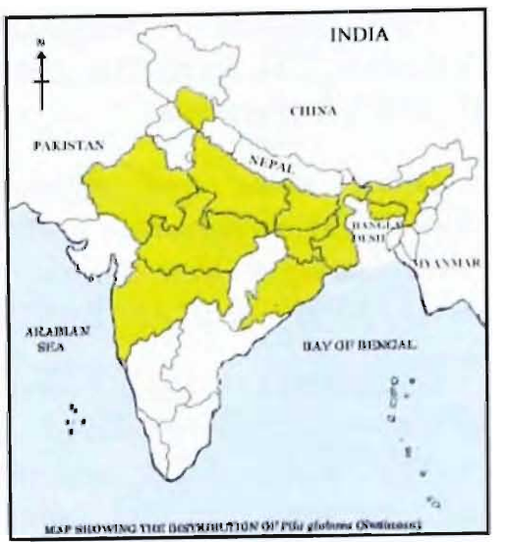
Pila globosa (Swainson, 1822)

1822. *Ampullaria globosa* Swainson, *Zool. Illustrations*, **2** : pl. xix. (Type locality : Rivers of India).

Fig. 56. A. Dorsal view of *Pila globosa* (Swainson)

Fig. 56. B. Ventral view of *Pila globosa* (Swainson)

Type location : Natural History Museum, London.



Latest name and Reference : *Pila globosa* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India,* p. 58, figs. 80-82.

Diagnosis : Shell globose with an inflated body whorl and depressed spire, suture shallow, coloured bands present inside the aperture. It shows remarkable variation in shape and elevation of the spire and body whorl.

Distribution : India : Assam, Bihar, Himachal Pradesh, Jharkhand, Maharashtra, Madhya Pradesh, Meghalaya: Garo Hills (South), Orissa, Rajasthan, Uttar Pradesh, West Bengal. Not recorded from Punjab.

Remarks : Commonest freshwater snail of India and has been the centre of investigation by a number of workers. Some of important contributions are Bahl (1928) on reproductive processes and development; Bhargava (1968) on physiology and structure of heart; Brahmanandan (1976) on physiology; Chatterjee (1960), Ghosh (1912) on nervous system; Prashad (1925) on biology and anatomy; Ranjha (1942) on embryology; Saxena (1955, 1956) on physiology and aestivation.

A number of trematodes species are recorded from this species. Anjaneyulu (1967) recorded *Artyfechinostomum sufratyfex* and *Diplodiscus* sp.; Ganapati and Rao (1968) *Echinostoma cercatria*; Ganapati *et.al* (1969) *Cercaria andhraensis* Rao *et al.*, *Cercaria pigmentata* and Sen (1949) *Xiphidocercaria* sp.

Pila globosa var ***incrassatula*** (Nevill)

1877. *Ampullaria globosa* var *incrassatula* Nevill, *Hand list Moll. Indian Mus.*, **parts 2** : 4. Type locality : Dum Dum, Calcutta.

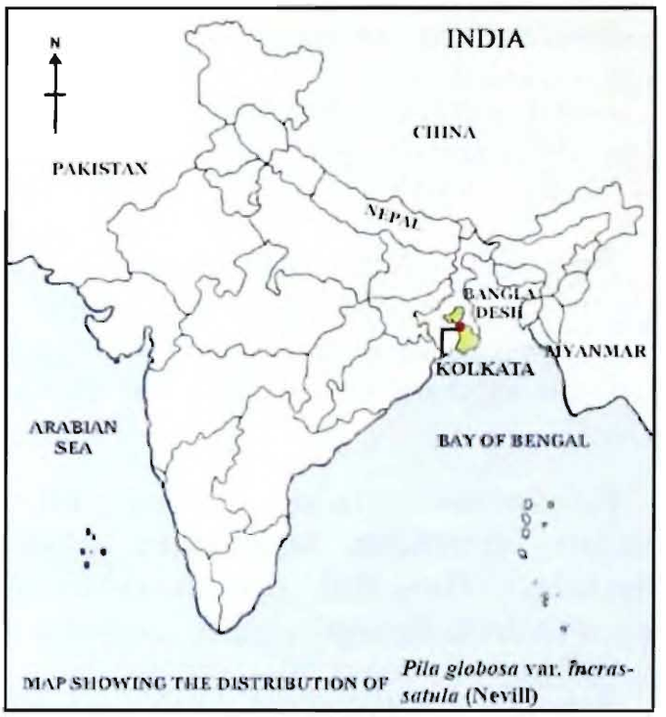
Fig. 57. A. Dorsal view of *Pila globosa* var ***incrassatula*** (Nevill)

Fig. 57. B. Ventral view of *Pila globosa* var ***incrassatula*** (Nevill)

Type location : National Zoological Collection, ZSI, Regd. No. 2399 (Holotype), M 25083/5 (Paratype).

Latest name and Reference : *Pila globosa* var *incrassatula* : Mitra and Dey, 1992. *Fauna of West Bengal, State Fauna Series,* **3**(Part-9), p. 15. *Zool. Surv. India.*

Diagnosis : Shell medium, thick, subglobose; spire produced and slightly exserted; whorls 5-5$^{1/2}$, moderately swollen and rounded above; suture slightly impressed; aperture ovidal; operculum thick and multinucleated; columellar callus narrow; lemon yellowish colour.



MAP SHOWING THE DISTRIBUTION OF *Pila globosa* var. *incrassatula* (Nevill)

It differs from typical form in having smaller shells with more produced spire and narrower umbilical opening.

Distribution : India: West Bengal: Kolkata, Hugli, 24-Paragonas (North).

Pila globosa var *minor* (Nevill)

1877. *Ampullaria globosa* var *minor* Nevill, *Hand list Moll. Indian Mus.*, part-2 : 4. Type locality : Dum Dum, Calcutta.

Fig. 58. A. Dorsal view of *Pila globosa* var *minor* (Nevill)

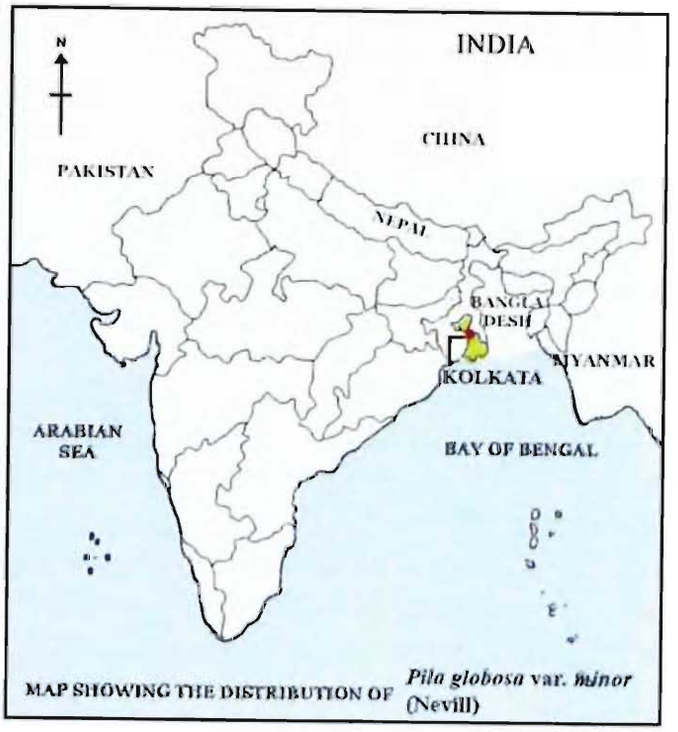
Fig. 58. B. Ventral view of *Pila globosa* var *minor* (Nevill)

Type location : National Zoological Collection, ZSI, Reg. No. 2445 (Holotype), M 25082/6 (Paratype).

Latest name and Reference : *Pila globosa* var *minor* : Mitra and Dey, 1992, *Fauna of West Bengal, State Fauna Series,* 3(Part-9), p. 15. *Zool. Surv. India.*

Diagnosis : Shell globose, thin with widely expanded columellar margin; spire produced; chestnut in colour with distinct colour bands on the surface as well as inside the aperture.

Authors have examined fresh collections of this variety from Sonarpur and Falta (24-Paraganas, South). These shells agree well with the type. The shells are thin with chocolate bands inside the mouth.



MAP SHOWING THE DISTRIBUTION OF *Pila globosa* var. *minor* (Nevill)

Distribution : India : West Bengal: Hugli, Kolkata, 24 Paraganas (South).

Pila scutata (Mousson, 1848)

1848. *Ampullaria scutata* Mousson, *Mitth. Naturf. Ges. Zurich,* **1** : 268. Type locality : Java.

1925. *Pila conica* : Prashad, *Mem. Indian Mus.*, **8** : 79, pl.xv, figs. 4-8.

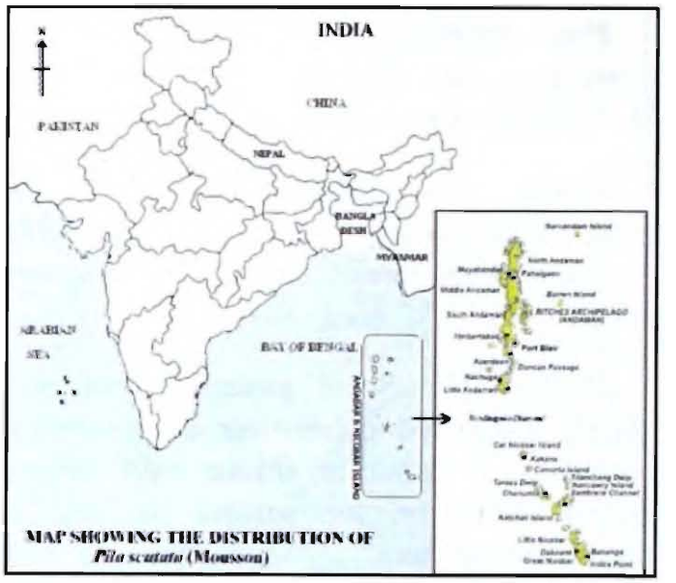
Fig. 59. A. Dorsal view of *Pila scutata* (Mousson)

Fig. 59. B. Ventral view of *Pila scutata* (Mousson)

1956. *Pila scutata* : Benthem Jutting, *Treubia*, **23**(2) : 332, figs. 37-40.

Type location : Natural History Museum, London.

Latest name and Reference : *Pila scutata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 59, fig. 83.



Diagnosis : Shell ovoid or semiglobose, with large bodywhorl; spire elongated; whorls descending step like; suture deeply impressed but without distinct carination; umbilicus narrow; olivaceous green with faint brownish spiral bands in young adults, deep brown colour with brownish spiral bands also distinct through the aperture.

Distribution : The typical form is widely distributed extending from Andaman and Nicobar Islands to Celebes and north to Philippines. Not found in Moluccas or New Guinea.

Pila scutata compacta (Reeve)

1856. *Ampullaria compacta* Reeve, *Conch. Icon.*, **10** : *Ampullaria*, pl. 14, fig. 62, pl. 15, fig., 71. Type locality : Malacca.

1925. *Pila conica* var. *compacta* : Prashad, *Mem. Indian Mus.*, **8** : 79, pl. 15, figs. 9, 10.

Fig. 60. A. Dorsal view of *Pila scutata compacta* (Reeve)

Fig. 60. B. Ventral view of *Pila scutata compacta* (Reeve)

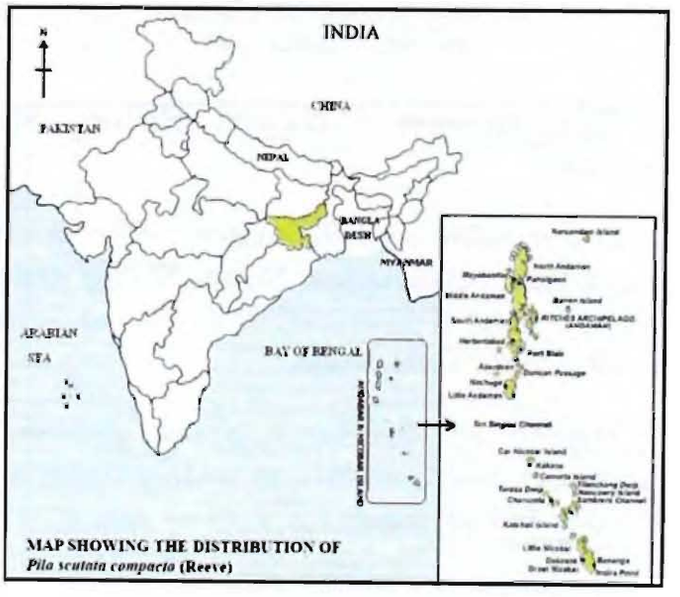
Fig. 61. A. External view of operculum of *Pila scutata compacta* (Reeve)

Fig. 61. B. Internal view of operculum of *Pila scutata compacta* (Reeve)

Type location : Natural History Museum, London.

Latest name and Reference : *Pila scutata compacta* : Subba Rao, Das and Mitra, 1980, *Rec. zool. Surv. India,* **77**, p. 227, pl., 2, fig., 2.

Diagnosis : Shell larger, thicker and stouter with strong vertical striations, sometimes making the shells quite malleated; columellar callus much broader; aperture more ovoid; darker in colour with faint transverse colour bands.



Distribution : India : Andaman and Nicobar Island, Jharkhand: Santhal Paragana.

Elsewhere : Myanmar to Celebes and North to the Philippines.

Remarks : Prashad (1925) remarked that the Reeve's types were labelled as from Malacca but the shells are very similar with the shells from Myanmar.

Pila theobaldi (Hanley, 1875)

1875. *Ampullaria theobaldi* Hanley, *Proc. zool. Soc. Lond.*, **1875** : 608. Type locality : Bhamo, Myanmar.

1925. *Pila theobaldi* : Prashad, *Mem. Indian Mus.*, **8** : 77, pl.xv, fig.3.

1989. *Pila theobaldi* : Subba Rao, *Handbook of Freshwater Molluscs of India*, : 60, fig. 84.

Fig. 62. A. Dorsal view of *Pila theobaldi* (Hanley)

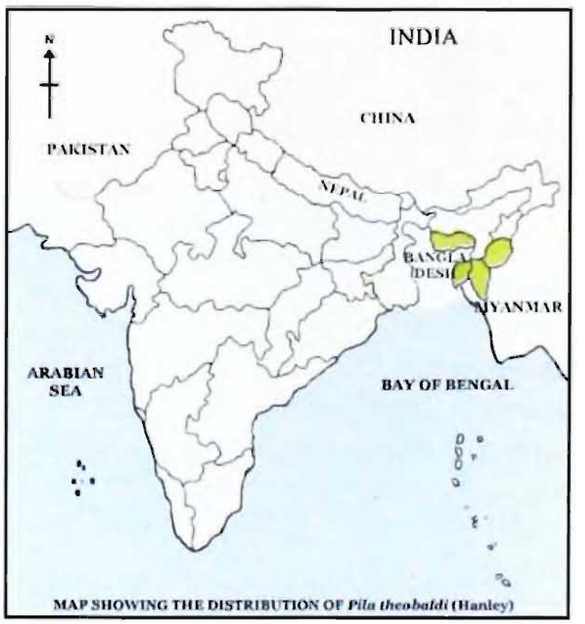
Fig. 62. B. Ventral view of *Pila theobaldi* (Hanley)

Type location : Natural History Museum, London.

Latest name and Reference : *Pila theobaldi* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 76. *Zool. Surv. India.*

Diagnosis : Shell large, whorls globose; suture more impressed; umbilicus widely open; aperture without colour bands.

Distribution : India : Tripura (West, North and South), Manipur: Imphal, Bishenpur; Meghalaya: Garo Hills (South, East and West), Jaintia Hills : Ri-Bhoi.



MAP SHOWING THE DISTRIBUTION OF *Pila theobaldi* (Hanley)

Elsewhere : Myanmar.

Pila virens (Lamarck, 1822)

1822. *Ampullaria virens* : Lamarck, *Hist. nat. Anim. Sans. Vert.*, **6**(2) : 179. Type locality : Not mentioned.

1856. *Ampullaria maura* : Reeve, *Conch. Icon.*, **10** : *Ampullaria,* sp. no. 57, pl. xiii, fig. 57.

1856. *Ampullaria olea* : Reeve, *Conch. Icon.*, **10** : *Ampullaria,* sp. no. 102, pl. xxi, fig. 102.

1921. *Pachylabra nevilliana* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 11, fig. 2. Type locality : Tranquebar.

1989. *Pila virens* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 60, fig. 87.

Fig. 63. A. Dorsal view of *Pila virens* (Lamarck)

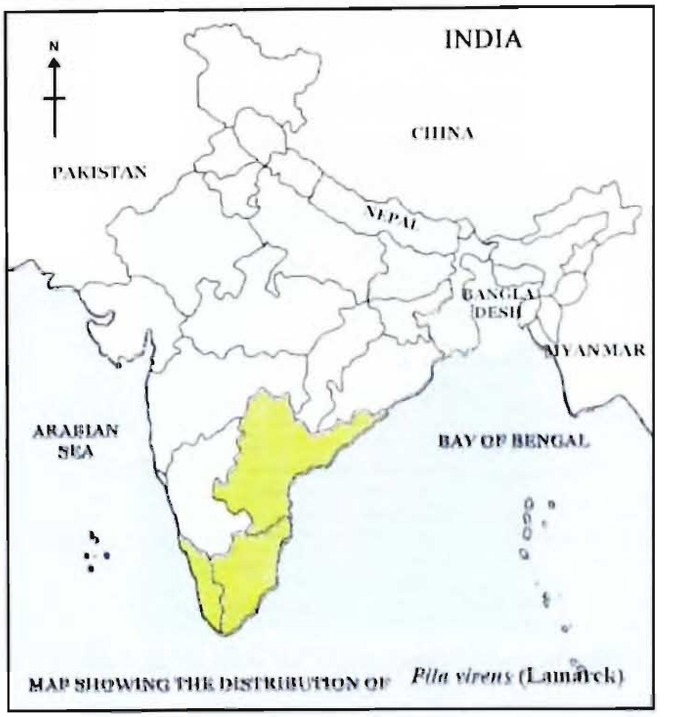
Fig. 63. B. Ventral view of *Pila virens* (Lamarck)

Type location : Museum D'Histoire Naturelle, Geneva.

Latest name and Reference : *Pila virens* Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series* **5**(Part 5), p. 191. *Zool. Surv. India.*

Diagnosis : Shell large, globose imperforate or subperforate, body whor highly inflated and shouldered above; spire short, sutures deep and distictly canaliculate, aperture ovate.

Distribution : Common species of South India. Andhra Pradesh: Cuddapah Khammam, Krishna, Prakasam, Srikakulum Visakhapatnam; Kerala. Maharashtra, Tami Nadu.



MAP SHOWING THE DISTRIBUTION OF *Pila virens* (Lamarck)

Remarks : This species is very variable in shape of spire, colour etc and sometimes it becomes difficult to distinguish it from the other common species, *Pila globosa.*

Important works on this species are Meenakshi (1951, 1954, 1955, 1956, 1957, 1964), Ramamoorthi (1955, 1958, 1959, 1960) and Shylaja and Alexander (1975).

Subgenus ***Turbinicola*** Annandale and Prashad, 1921

1921. *Turbinicola* Annandale and Prashad, *Rec. Indian Mus.*, **22** : 9. Type species : *Ampullaria nux* (= *Ampullaria saxea*) Reeve.

Shell comparatively small, ovate, aperture high and narrow, sculpture with minute spiral and longitudinal striae; umbilicus closed; lateral and marginal teeth of radula with two cups, inner one vestigial, outer expanded and obliquely truncate.

Animal in general resembles with *Pila* but there are certain changes in the anatomical structures due to its habitat. The branchial and pulmonary chambers of the mantle cavity are distinctly separated by well developed epitaenia. Lung well developed and more functional.

Restricted in hill streams of Western Ghat (India) and Myanmar.

Only one species recorded from streams of Western Ghat.

Pila (Turbinicola) saxea (Reeve, 1856)

1856. *Ampullaria saxea* Reeve, *Conch. Icon.*, **10** : *Ampullaria*, pl. xxii, fig. 108. Type locality : Streams near Khandalla (Prashad, 1925).

1925. *Turbinicola saxea* : Prashad, *Mem. Indian Mus.*, **8** : 87, pl. xiv, figs. 10-12.

Type location : Natural History Museum, London.

Fig. 64. A. Dorsal view of *Pila (Turbinicola) saxea* (Reeve, 1856)

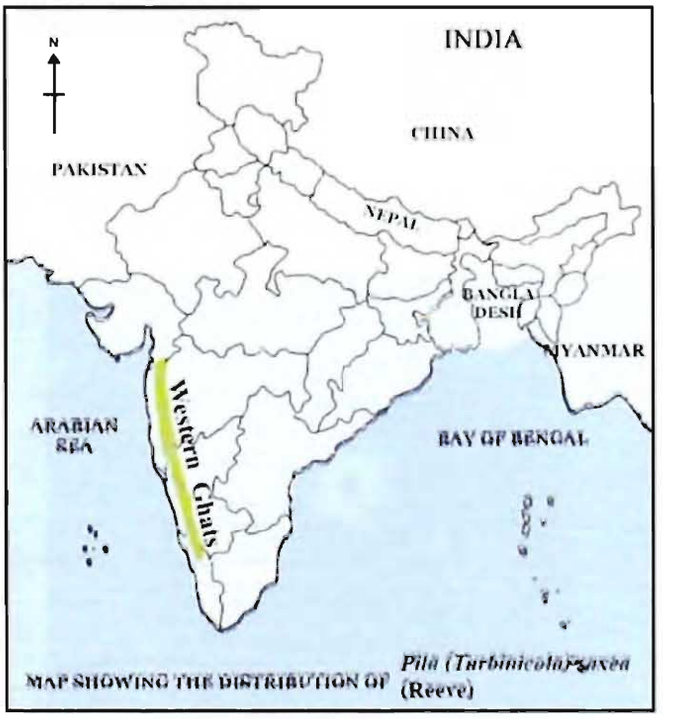
Fig. 64. B. Ventral view of *Pila (Turbinicola) saxea* (Reeve, 1856)

Latest name and Reference : *Turbinicola saxea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 61, fig. 86.

Diagnosis : Shell oblong-ovate, rather solid, with a narrow umbilicus, spire rather obtuse, whorls a little depressed round the upper part, obsoletely angled, then rounded; olive; aperture pyriformly oblong, collumellar lip thinly reflected.

Distribution : India : Maharashtra : Hill streams around Khandalla and Igatpuri, Western Ghats; Mumbai.

Elsewhere : Bassein, Pegu.



Superfamily VALVATOIDEA

Family VALVATIDAE

Shell small, dextral, discoidal to ovate, with distinct, widely open umbilicus; operculum circular, corneous and multispiral. Animal with a feather like bipectinate gill and tentacle like appendages projecting from the mantle edge. Central tooth without basal denticles. Hermaphrodite and Oviparous.

Valvatidae is exclusively a freshwater family. This species lives on the bottom mud of streams and lakes, scavenger in habit. It breeds in summer in its first year and usually dies thereafter.

Only one Genus widely distributed in North America, Europe, Asia and North-East Africa (Brown, 1980). In India this genus is represented from Kashmir.

Genus ***Valvata***, Mueller, 1774

1774. *Valvata*, Mueller, *Verm. Terr. Fluv. Hist.*, **2** : 198. Type species : *Valvata cristata* Mueller.

Shell small, turbinate or discoidal, whorls few, spire exerted, aperture oblique and circular, operculum corneous, multispiral.

Brown (1980) had given detail distribution of the genus. In India only one species represented from Kashmir.

Valvata piscinalis (Mueller, 1784)

1774. *Nerita piscinalis* Mueller, *Verm. Terr. Fluv. Hist.*, **2** : 172. Type locality : Europe.

1968. *Valvata piscinalis* : Rajagopal and Subba Rao, *Proc. Symp. Mollusca* : pt. 1, p. 98.

Type location : Not known.

Fig. 65. A. Dorsal view of *Valvata piscinalis* (Mueller)

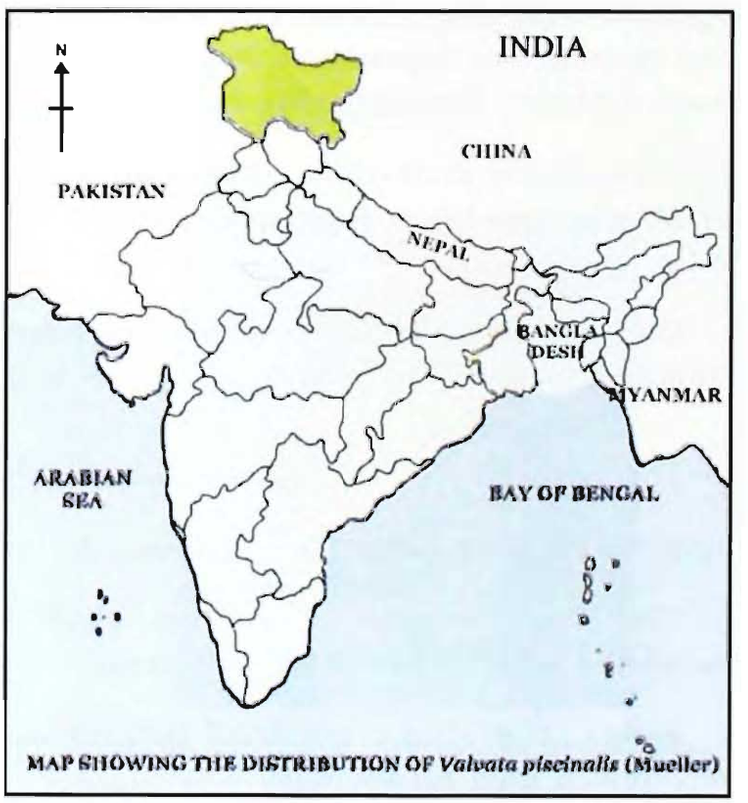
Fig. 65. B. Ventral view of *Valvata piscinalis* (Mueller)

Latest name and Reference : *Valvata piscinalis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 56.

Diagnosis : Shell globose, brownish yellow, whorls 5-6, deeply and narrowly umbilicate, depressed at the apex, with dense, fine longitudinal striations and faint spiral ridges.

Distribution : India : Kashmir.

Elsewhere : Europe.



MAP SHOWING THE DISTRIBUTION OF *Valvata piscinalis* (Mueller)

Superfamily LITTORINOIDEA

Family LITTORINIDAE

Shell thick, imperforate, turbinate, whorls more or less rounded; sculpture smooth or spirally striate, axially furrowed or nodulose; aperture ovate, operculum horny and paucispiral.

Mainly a marine family extending to estuaries and also in freshwater.

Among the family Littorinidae the genus *Cremnoconchus* is the only freshwater inhabitants of wet rocks of the hill streams of eastern India and genus *Mainwaringia* is found in slight saline water in the lower part of gangetic delta.

Subfamily LITTORININAE

Genus ***Mainwaringia*** Nevill, 1884

1884. *Mainwaringia* Nevill, *Hand List Moll. Indian Mus.*, **2** : 286. Type species : *Mainwaringia paludomoidea* Nevill.

Shell conical, imperforate; spire acuminate; columella strongly arched, outer lip sharp; sculpture with deeply cut spiral striae, with thin epidermis and scattered chaetae; operculum extremely thin, horny, paucispiral with excentric nucleus.

Animal with pointed foot and produced into short filamentous process posterior, a distinct mid-dorsal groove on posterior part of the foot extending on the terminal process. Gangetic delta.

Mainwaringia paludomoidea (Nevill, 1884)

1884. *Melania (Mainwaringia) paludomoidea* Nevill, *Hand List Moll. Indian Mus.*, **2** : 286. Type locality : Matlah river near Port Canning.

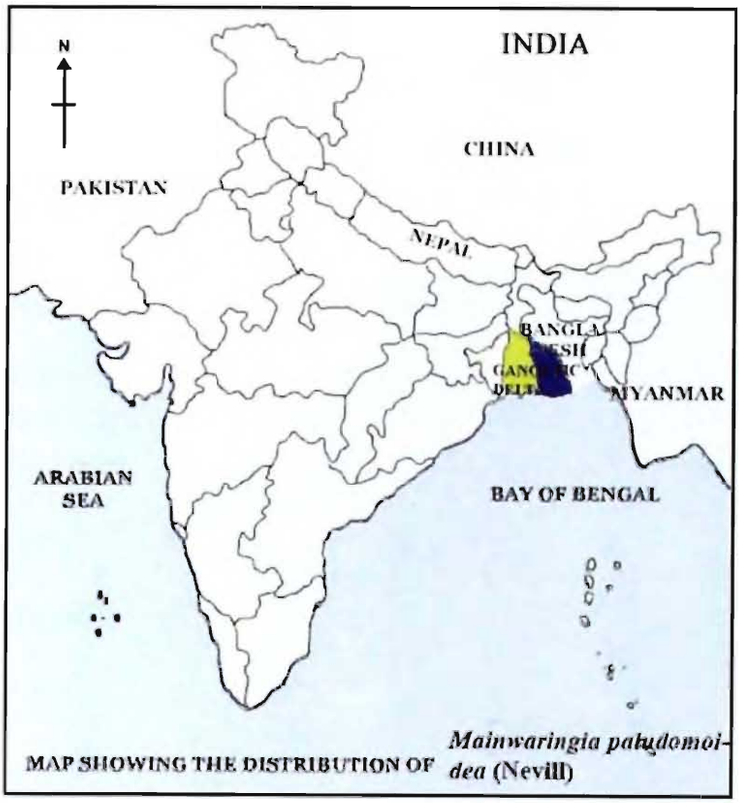
Fig. 66. A. Dorsal view of *Mainwaringia paludomoidea* (Nevill)

Fig. 66. B. Ventral view of *Mainwaringia paludomoidea* (Nevill)

1919. *Melania (Mainwaringia) paludomoidea* : Annandale and Prashad, *Rec. Indian Mus.*, **16** : 252, pl. xx. fig. 8.

Type location : National Zoological Collection, ZSI, Regd. No. 1183 (Syntypes).

Latest name and Reference : *Thiara (Mainwaringia) paludomoidea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 106. figs. 214, 215.



MAP SHOWING THE DISTRIBUTION OF *Mainwaringia paludomoidea* (Nevill)

Diagnosis : Shell conically produced, suture distinct, bright yellowish brown, body whorl with three distinct, broad, dark brown bands, showing clearly through the aperture, sculpture with spiral striae, which become prominent just below the suture, surface covered with rather long and well developed hairs.

Foot small, tentacles long and slender, snout prominent, blunt and slightly notched in front, foot and tentacles translucent white with black tip, snout brownish.

Distribution : India : Gangetic Delta. Attached on the trunks and aerated root of mangroves trees submerged at high tide.

Subfamily BEMBICIINAE

Genus ***Cremnoconchus*** Blanford, 1869

1869. *Cremnoconchus* Blanford, *Ann. Mag. Nat. Hist.*, (4)**3** : 343. Type species : *Cremnoconchus syhadrensis* Blanford, Original designation.

Shell turbinate or globose sculpture smooth or with spiral striae, periostracum thick; aperture subovate, operculum paucispiral.

Animal with thick and short snout, with very long tentacles; mantle margin with finger like projections; penis large.

A freshwater genus of the family Littorinidae, endemic to the hill streams of Western Ghat.

Cremnoconchus syhadrensis (Blanford, 1863)

1863. *Cremnobates syhadrensis* Blanford, *Ann. Mag. Nat. Hist.*, (3)**12** : 184, pl.iv, fig. 1-7. Type locality : Syhadri hills, Khandala, Pune Dist.

1869. *Cremnoconchus syhadrensis* : Blanford, *Ann. Mag. Nat. Hist.*, (4)**3** : 343.

1979. *Cremnoconchus syhadrensis* : Subba Rao and Mitra, *Rec. zool. Surv. India*, **75** : 24.

Type location : Not known.

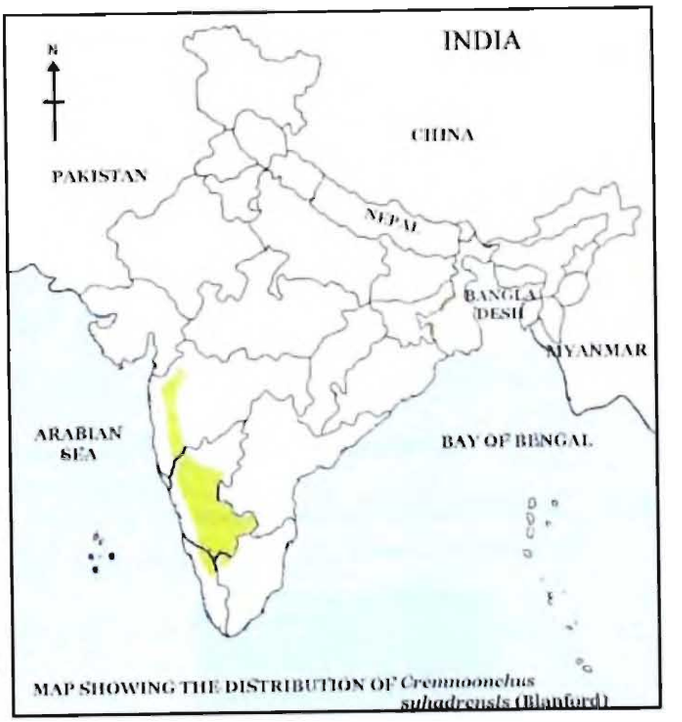
Fig. 67. A. Dorsal view of *Cremnoconchus syhadrensis* (Blanford)

Fig. 67. B. Ventral view of *Cremnoconchus syhadrensis* (Blanford)

Latest name and Reference : *Cremnoconchus (Cremnoconchus) syhadrensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 63, figs. 88, 89, 89a,b.

Diagnosis : Shell globose, perforate, periostracum olive green to brown, whorls 4½, body whorl large, sutures distinct, sculptured with distinct spiral granular ridges in the upper half and fine spiral striae in the lower half, aperture oval, a broad white band in between two brown bands inside the aperture, columella slightly reflected, with callus, outerlip thin.

Distribution : India : Maharashtra (Western Ghats).



Subgenus *Lissoconchus* Thiele, 1931

1931. *Lissoconchus* Thiele, *Syst. Wiech.*, **1** : 125.

Shell higher than broad; sculpture without any spiral ridges or striae; spire conical; body whorl with slight or prominent keel.

Cremnoconchus (Lissoconchus) carinatus (Layard, 1854)

1854. *Anculotus carinatus* Layard, *Proc. zool. Soc. Lond.*, **1854** : 94. Type locality : "Streams in the Mahakeshwar" (= Mahabaleshwar) hills.

1870. *Ctremnoconchus carinatus* : Blanford, *J. Asiat. Soc. Beng.* **39**(2) : 12, pl. 3, fig. 5.

Type location : Natural History Museum, London.

Fig. 68. A. Dorsal view of *Cremnoconchus (Lissoconchus) carinatus* (Layard)

Fig. 68. B. Ventral view of *Cremnoconchus (Lissoconchus) carinatus* (Layard)

Latest name and Reference : *Cremnoconchus (Lissoconchus) carinatus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 63, figs. 90, 91.

Diagnosis : Shell ovately conical, spire short and exerted, whorls inflated, sharply keeled in the middle; sculptured with minute longitudinal striations; shell olive-yellow in colour, marked with two indistinct broad, brown bands, seen distinctly in the aperture, columellar side slightly callus and white.

Distribution : India : Maharashtra: Mahabaleshwar hills.

Cremnoconchus (Lissoconchus) conicus (Blanford, 1870)

1870. *Cremnoconchus conicus* Blanford, *J. Asiat. Soc. Beng.*, **39**(2) : 10, pl. 3, fig. 3. Type locality : Torna hills, near Pune.

Fig. 69. A. Dorsal view of *Cremnoconchus (Lissoconchus) conicus* (Blanford)

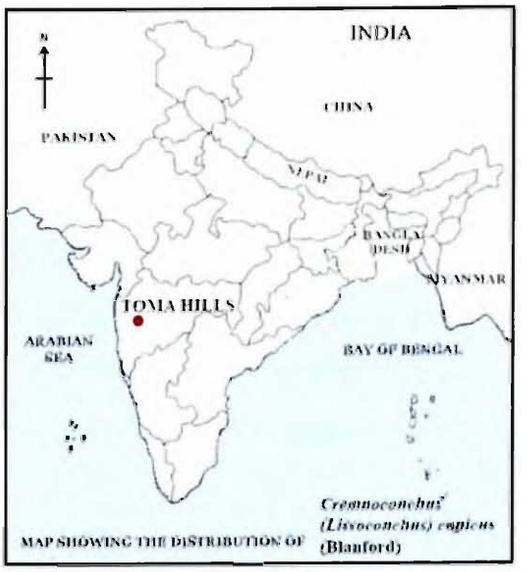
Fig. 69. B. Ventral view of *Cremnoconchus (Lissoconchus) conicus* (Blanford)

Type location : Not known.

Latest name and Reference : *Cremnoconchus (Lissoconchus) conicus* : Subba Rao, 1989. *Handbook of Freshwater Molluscs of India*, p. 64, figs. 92, 93.

Diagnosis : Shell ovately conical, spire conical, sutures distinct, angle at the periphery slightly marked in the typical form.

Distribution : India : Maharashtra: Torna hills, near Pune.



Superfamily RISSOIDEA

Family HYDROBIIDAE

Shell small, dextral, mostly globose or turreted, some depressed. Umbilicate to imperforate. Aperture ovate. Operculum, thin, paucispiral, corneous. Snout long, terminally a little divided; foot simple, broad, not divided, anteriorly truncate and rounded posteriorly. Radula 2-1-1-1-2. Central tooth broader than long, commonly with one or more basal denticles. Oesophagus without gland, stomach with crystalline style. Verge slightly to the right of mid dorsum and without flagellum. Sexes separate female oviparous or viviparous, male with a penis attached to right side of neck and lacking an acessory lobe.

Cosmopolitan in brackish and freshwaters, with a particularly rich assemblage of genera in South East Asia.

Subfamily POTAMOPYRGINAE

Genus ***Potamopyrgus*** Stimpson

1865. *Potamopyrgus* Stimpson, *Am. J. Conch.*, **i** : 54.Type species : *Melania corolla* Gould.

Shell less than 12 mm high, ovate or turreted, periostracum with spines or bristles. Operculum corneous with a calcareous smear in some species. Central tooth of radula has a slight projection from its base, and 3-5 basal denticles on each side. Sexes separate. Female oviparous or ovo-viviparous. Males rare.

Asia, Europe, Africa, Australia and New Zealand.

Found in fresh and brackish water. Only one species reported from India (Andaman Islands).

Subgenus ***Indopyrgus*** Thiele, 1928

1928. *Indopyrgus,* Thiele, *Zool. Jahrbuch., (Syst. Abth),* **55**. Type species : *P. (I.) nevilli* Thiele.

Shell smooth, radular with finely toothed central. Similar to *Amnicola*

Potamopyrgus (Indopyrgus) nevilli Thiele, 1928

1928. *Potamopyrgus (Indopyrgus) nevilli* Thiele, *Zool. Jahrbuch., (Syst. Abth),* **55** : 373, pl. 8, fig. 7. Type locality : Andamans.

Type location : Berlin Museum, Berlin.

Latest name and Reference : *Potamopyrgus (Indopyrgus) nevilli* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 65.

Diagnosis : Shell oval, smooth; spire short and blunt, body whorl large, aperture slightly oblique, oval, margins thickened; operculum thin, transparent and paucispiral.

Distribution : Not known beyond Andamans (Except type no other material recorded).

Family BITHYNIIDAE

Shell medium to small, dextral, ovate to elongate-turreted, narrowly umbilicate to imperforate; whorls moderately convex; aperture rounded or ovate, sometimes expanded; peristome thickened, continuous, columelar fold ridge like operculum wholly or partly calcareous, with a spiral central part and concentric outer area, with spiral nucleus.

Tentacles long and thin, bearing eyes on lateral side. Radula 2-1, central tooth usually with basal denticles on either side of the broad basal plate. Sexually dimorphic. Oviparous. Males with a flagellum on the penis. Verge located on the dorsal side of the neck, curved, fleshy and bifid.A long finger like appendage on the inner concave part. A small cusp shaped skin flap attached to the right side of the head just behind the right tentacle.

Cosmopoliton. Found in freshwater streams, stagant water pools and paddy fields.

Three genera namely *Bithynia, Gabbia* and *Mysorella* represented from India.

Some of the important contributions to the family are Abbott (1948), Annandale (1920, 1924), Annandale and Prashad (1921, 1924), Annandale, Prashad and Kemp (1919), Bentham-Jutting (1956), Pace (1973) and Walker (1925, 1927).

Key to the genera

1. Shell thick, turbinate with strong spiral ridges; columellar fold not ridge like; central tooth without latero-basal denticulations but with a single downwardly directed blunt process on either side ..... *Mysorella* Godwin-Austen

– Shell not thick, smooth or with fine spiral ridges; columellar fold ridge like; central tooth with a series of latero-basal denticulations on either side .....(2)

2. Operculum with a paucispiral figure situated in the middle of the lower part, transaprent; columellar fold ridge like a defenite, not prominent groove running from the umbilicus is absent ..... *Gabbia* Tryon

– Operculum concentric, thick with central or subcentral nucleus; columellar fold ridge like and prominent, a well defenite groove running downwards from umbilicus ..... *Bithynia* Leach

Genus ***Bithynia*** Leach, 1818

1818. *Bithynia* Leach, In : Abel's, *Narrative of Journey into interior of China* : 362. Type species : *Helix tentaculata* Linnaeus, 1758.

Shell up to 15 mm high, elongately conical and acuminate. Spire conical, perforate and constricted, with a well developed groove extending obliquely downwards from umbilicus to columellar fold. Whorls convex; operculum heavily calcareous, concentric with a small spiral nucleus. Lateral teeth of radula greatly enlarged, marginal teeth minute and sharp.

Widespread in Europe, Asia and Africa.

Vaught (1989) included one subgenus *Digoniostoma* Annandale under the genus *Bythinia* Leach. Six species of this genus reported from India, two under genus *Bithynia* restricted to Kashmir only and four under subgenus *Digoniostoma* reported from throughout India.

Key to the species

1. Outer lip thick, produced and angulate or subangulate at its inner extremity .....(2)

– Outer lip thin, not produced and angulate or subangulate at its inner extremity.(4)

2. Lip at the base of columella produced, spire shorter than body whorl .....(3)

– Lip at the base of columella not produced, spire equal or more than body whorl.. .....*B. (D) pulchella* (Benson)

3. Shell elongated, suture impressed ..... *B.(D) cremeopoma* (Benson)

– Shell oval, suture not impressed ..... *B.(D) textum* Annandale

4. Shell ovately fusiform, spire not much pointed, aperture ovate .... *B. troscheli* (Paasch)

– Shell conically ovate, spire more pointed, aperture pyriformly ovate .... *B. tentaculata kashmirensis* (Nevill)

Bithynia tentaculata kashmirensis (Nevill, 1884)

1884. *Bithynia tentaculata* var. *kashmirensis* Nevill, *Hand List Moll. Indian Mus.*, **2** : 39. Type locality : Srinagar, Kashmir.

1968. *Bithynia tentaculatus* var.*kashmirensis* : Rajagopal and Subba Rao, *Proc. Symposium Mollusca*, Mandapam : pt. 1, p. 99.

Type location : National Zoological Collections, ZSI, Regd. No. M 2236.

Fig. 70. A. Dorsal view of *Bithynia tentaculata kashmirensis* (Nevill)

Fig. 70. B. Ventral view of *Bithynia tentaculata kashmirensis* (Nevill)

Latest name and Reference : *Bithynia tentaculata kashmirensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 74.

Diagnosis : Shell conically ovate, whorls 5, smooth, convex, apex rather sharp, umbilicus almost closed, aperture pyriformly ovate, lip with dark edge and scarcely reflected. Operculum with a central nucleus, greenish brown.

Distribution : India : Kashmir (Common in Paddy fields); Salt Range, Punjab.

MAP SHOWING THE DISTRIBUTION OF *Bithynia tentaculata kashmirensis* (Nevill)

Bithynia troscheli (Paasch, 1842)

1842. *Paludina troscheli* Paasch, *Archiv. Fur Naturgeschaft*, **1842** : 300, pl. 6, figs. A-D.

1915. *Bithynia troscheli* : Preston, *Fauna of British India, Mollusca.* (Freshwater Gastropoda and Pelecypoda) : 77.

Fig. 71. A. Dorsal view of *Bithynia troscheli* (Paasch)

Fig. 71. B. Ventral view of *Bithynia troscheli* (Paasch)

Type location : Not known.

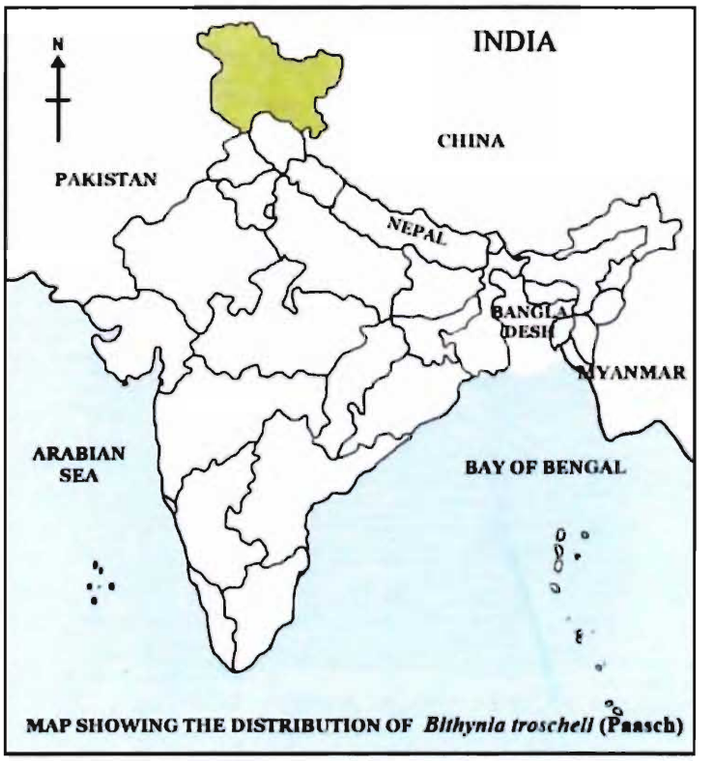
Latest name and Reference : *Bithynia troscheli* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 74.

Diagnosis : Shell small, ovately fusiform, suture rather deep, aperture ovate.

Distribution : India : Kashmir.

Elsewhere : Europe.

Remarks : Preston (1912) reported this species from Kashmir is doubtful.



MAP SHOWING THE DISTRIBUTION OF *Bithynia troschelli* (Paasch)

Subgenus ***Digoniostoma*** Annandale, 1920

1920. *Digoniostoma* Annandale, *Indian J. Med. Res.*, **7** : 104. Type species : *Paludina cerameopoma* Benson

Shell upto 15 mm high, pyramidal or elongately ovate. Whorls convex, body whorl large and inflated; sculpture finely striated and narrowly perforate. Aperture rounded, peristome continuous, somewhat expanded at the base, columellar callus broad, thick, prominent and with laminated appearance. Operculum calcareous, spirally coiled with central nucleus. Central tooth of radula with small cusps in basal corners.

Common in stagnant freshwater like ponds, lakes, pools, ditches or small sluggish stream.

India, China, Malay Archipelago, New Guinea, Philippines and Siam.

Bithynia (Digoniostoma) cerameopoma (Benson, 1830)

1830. *Paludina cerameopoma* Benson, *Gleanings in Science,* Calcutta, **2** : 125. Type locality : Ditch at Nanda, Madhya Pradesh.

1989. *Digoniostoma cerameopoma* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 79, fig. 121.

Type location : Cambridge University Museum, Cambridge.

Latest name and Reference : *Digoniostoma cerameopoma* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 192. *Zool. Surv. India.*

Fig. 72. A. Dorsal view of *Bithynia (Digoniostoma) cerameopoma* (Benson)

Fig. 72. B. Ventral view of *Bithynia (Digoniostoma) cerameopoma* (Benson)

Diagnosis : Shell oblong-ovate, whorls 5, regularly and rather rapidly increasing, sculpture with very fine, weak spiral striae and weak growth lines, suture well impressed, umbilicus moderately narrow and deep, peristome continuous and slightly reflected, aperture oval and oblique. Operculum calcareous, concave, nucleus sub central.

Distribution : India : Andhra Pradesh: Annantapur, Khammam, Medak, Prakasam, Srikakulum; Assam, Bihar, Delhi, Jharkhand, Madhya Pradesh, Meghalaya: Garo hills (West); Punjab, Rajasthan, West Bengal: Kolkata, Haora, Hugli, 24-Paraganas (North).

MAP SHOWING THE DISTRIBUTION OF *Bithynia (Digoniostoma) ceramcopoma* (Benson)

Elsewhere : Pakistan.

Bithynia (Digoniostoma) evezardi (Blanford, 1880)

1880. *Bithynia evezardi* Blanford, *J. Asiat. Soc. Beng.*, **49**(2) : 220. Type locality : Lanaoli, between Bombay (Mumbai) and Pune.

1881. *Bithynia evezardi* : Nevill, *J. Asiat. Soc. Beng.*, **50**(2) : 157, pl. 6, fig. 13.

Fig. 73. A. Dorsal view of *Bithynia (Digoniostoma) evezardi* (Blanford)

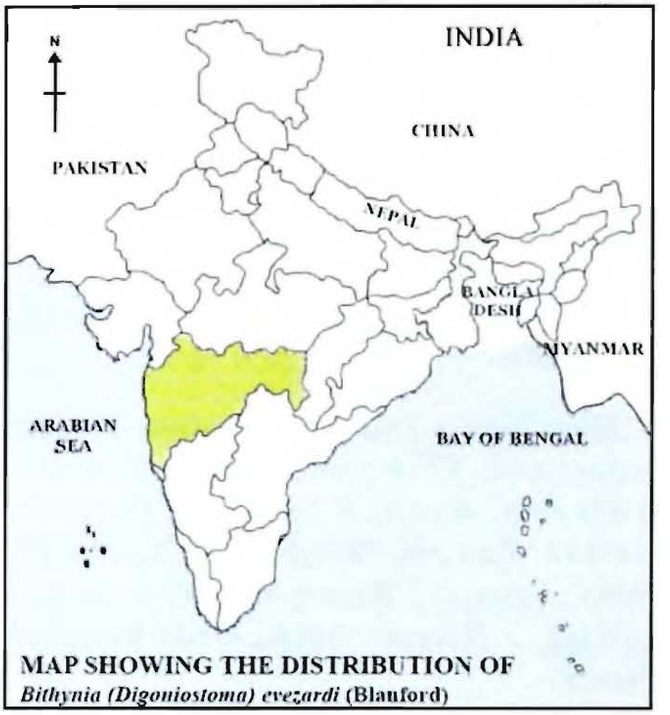
Fig. 73. B. Ventral view of *Bithynia (Digoniostoma) evezardi* (Blanford)

Type location : Not known.

Latest name and Reference : *Sataria evezardi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 75, figs. 117, 118.

Diagnosis : Whorls 4-5, rounded, spire conical, sutures deeply impressed, sculpture with regular, close and impressed spiral lines. Aperture oval, subangulate at the anterior and posterior ends, peristome simple, straight, obtuse, umbilicus distinct.

Distribution : India : Maharashtra: Khandala and Mahabaleshwar.



MAP SHOWING THE DISTRIBUTION OF *Bithynia (Digoniostoma) evezardi* (Blanford)

Bithynia (Digoniostoma) pulchella (Benson, 1836)

1836. *Paludina pulchella* Benson, *J. Asiat. Soc. Beng*, **5** : 746. Type locality : Mirzapur, Uttar Pradesh.

1876. *Paludina pulchella* : Hanley and Theobald, *Conch. Indica*, pl. 38, figs. 5, 6.

1989. *Digoniostoma pulchella* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 80, figs. 113, 114, 119, 120.

Fig. 74. A. Dorsal view of *Bithynia (Digoniostoma) pulchella* (Benson)

Fig. 74. B. Ventral view of *Bithynia (Digoniostoma) pulchella* (Benson)

Type location : Cambridge University Museum, Cambridge.

Latest name and Reference : *Digoniostoma pulchella* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part 5), p. 193. *Zool. Surv. India.*

Diagnosis : Shell elongate, spire longer than the body whorl, sutures depressed, umbilicus almost closed, and aperture oval.

Distribution : Throughout India.

Elsewhere : Myanmar, Malay Archipelago and Pakistan.

MAP SHOWING THE DISTRIBUTION OF *Bithynia (Digoniostoma) pulchella* (Benson)

Bithynia (Digoniostoma) textum Annandale, 1921

1921. *Digoniostoma textum* Annandale, *Rec. Indian Mus.*, **22** : 541, fig. 1, 2. Type locality : Manipur.

Type location : National Zoological Collection, ZSI, Regd. No. M 11860/2.

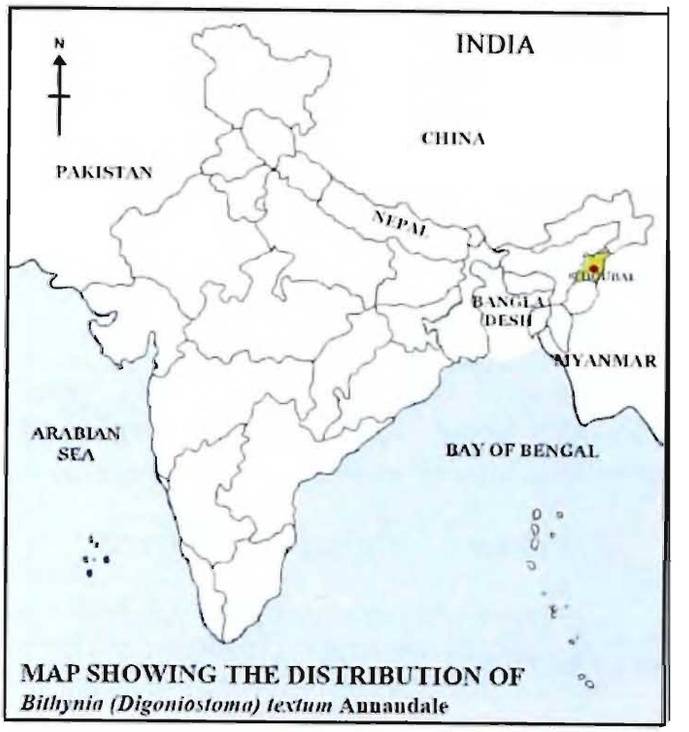
Fig. 75. A. Dorsal view of *Bithynia (Digoniostoma) textum* Annandale

Fig. 75. B. Ventral view of *Bithynia (Digoniostoma) textum* Annandale

Latest name and Reference : *Digoniostoma textum* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 80, fig. 115, 116.

Diagnosis : Whorls 4½, spire shorter than the body whorl, suture oblique, not much impressed, aperture narrowly oval, posteriorly the outer lip meets the columellar callus at an angle slightly greater than a right angle, columellar margin arched, prominent and thick, umbilicus almost closed; operculum large, moderately thick, internally convex and granular.

Distribution : India : Manipur : Thoubal [Endemic to Manipur]



Genus ***Gabbia*** Tryon, 1865

1865. *Gabbia* Tryon, *Amer. J. Conch.*, **1** : 216. Type species : *Gabbia australis* Tryon.

Shell globose with tumid whorls; body whorl large, suture wide, imperforate or subumbilicate, columellar fold ridge like but not so prominent; operculum thick, calcareous but usually hyaline or sub hyaline, distinctly spiral and with slightly concentric nucleus, ornamented round the margin with concentric line.

Foot short, rounded or pointed posteriorly and angulate anteriorly, snout long and narrow. Radula similar with genus *Amnicola,* central tooth with distinct quadrate projection on the disc. Verge (penis) large, flattened and almost in the middle.

India, Australia and Mesopotamia.

Key to the species

1. Shell ovately fusiform, not much thick, body whorl not much swollen, columellar callus not well developed .....(2)

– Shell globose, thick, body whorl swollen, columellar callus well developed .... *G. stenothyroides* (Dohrn)

2. Shell with rounded whorls, suture deep, columellar margin descending at an angle .....*G. orcula* Frauenfeld

– Shell with obliquely rounded whorls, suture not deep, columellar margin ridgelike and descending straight ..... *G. travancorica* (Benson)

Gabbia orcula Frauenfeld, 1862

1862. *Bithynia orcula* Frauenfeld, *Varhandl. Zool. Bot. Geschaft*, p. 1154. (Type locality : in Cuming's Sammlung Von Ganges, Renewalla, Ceylon, Barrackpore).

1876. *Bithynia orcula* : Hanely and Theobald, *Conch. Indica* : pl. 38, figs. 8, 9.

1921. *Amnicola (Alocinma) orcula* : Annandale, *Rec. Indian Mus.*, **22** : 540.

1989. *Gabbia orcula* : Subba Rao, *Handbook of Freshwater Molluscs of India* : 76.

Fig. 76. A. Dorsal view of *Gabbia orcula* Frauenfeld

Fig. 76. B. Ventral view of *Gabbia orcula* Frauenfeld

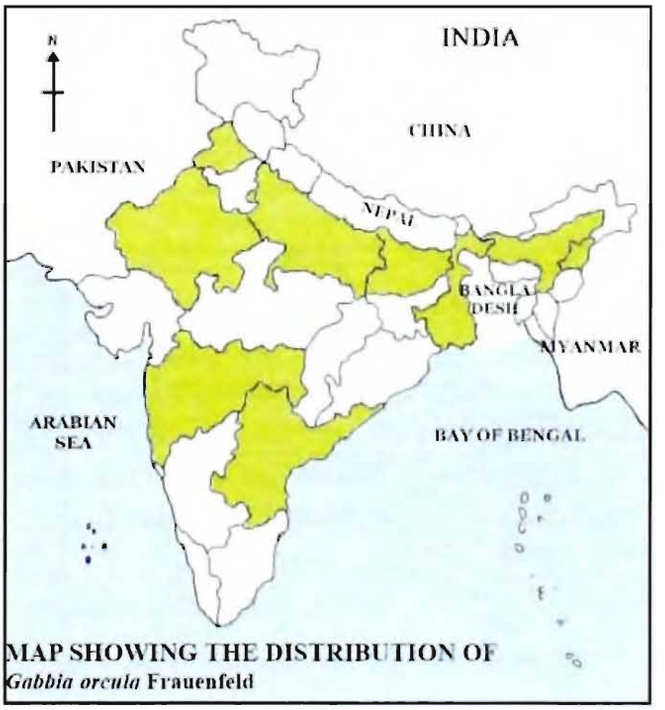
Type location : Not known.

Latest name and Reference : *Gabbia orcula* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 194. *Zool. Surv. India*:

Diagnosis : Shell globosely conic, smooth, almost imperforate, whorls 4, slightly rounded, body whorl swollen, suture deep, columellar margin not much reflected.

Distribution : India : Andhra Pradesh: Annantpur, Hyderabad, Khammam; Assam, Bihar, Delhi, Jharkhand, Maharashtra, Manipur: Bishenpur, Chandel, Churachandpur, Thoubal; Punjab, Rajasthan, Uttar Pradesh, West Bengal.

. *Elsewhere* : Malaya Archipelago; Myanmar; Pakistan.



MAP SHOWING THE DISTRIBUTION OF *Gabbia orcula* Frauenfeld

Gabbia orcula var. ***producta*** (Nevill, 1884)

1884. *Bithynia orcula* var. *producta* Nevill, *Hand List Moll. Indian Mus.*, **2** : 37. Type locality : Not mentioned.

1963. *Alocinma orcula* var. *producta* : Ray and Mukherjee, *Rec. zool. Surv. India*, **61** : 420, pl. 19, figs. 1, 1a.

Type location : No designation was made.

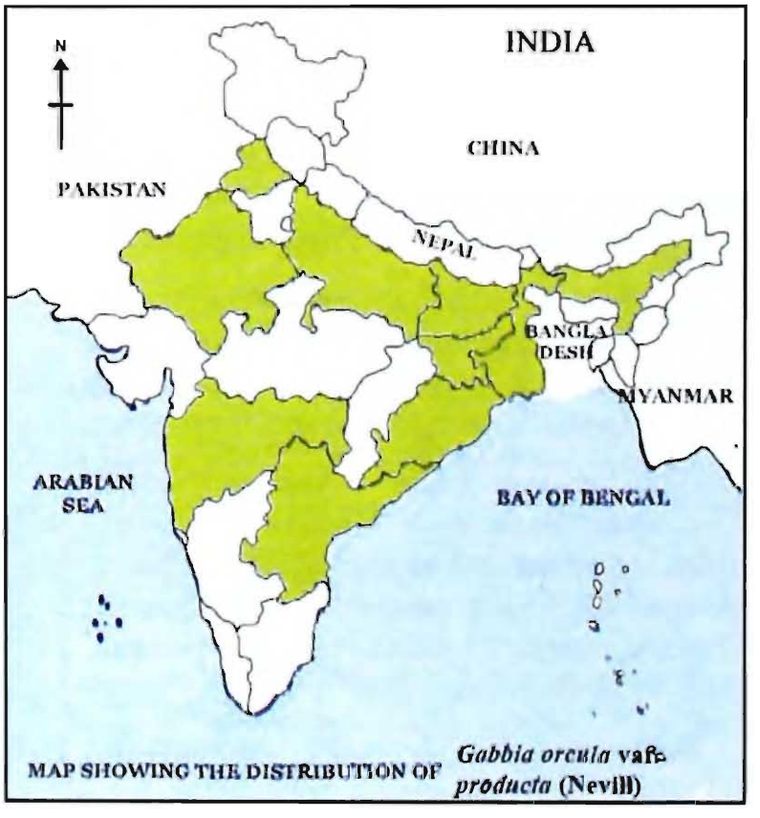
Fig. 77. A. Dorsal view of *Gabbia orcula* var. *producta* (Nevill)

Fig. 77. B. Ventral view of *Gabbia orcula* var. *producta* (Nevill)

Latest name and Reference : *Gabbia orcula* var. *producta* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 77, fig. 142.

Diagnosis : Shell much narrower and more elongate than in the typical form.

Distribution : India : Andhra Pradesh, Assam, Bihar, Jharkhand : Santhal Paragana; Maharashtra Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal : Kolkata, 24 Paraganas (North and South), Bankura, Birbhum, Hugli, Midnapore, Nadia, Puruliya.



MAP SHOWING THE DISTRIBUTION OF *Gabbia orcula* var. *producta* (Nevill)

Gabbia stenothyroides (Dohrn, 1857)

1857. *Bithynia stenothyroides* Dohrn, *Proc. zool. Soc. Lond.*, **1857** : 123. (Type locality : Ceylon, Nilgheries).

1876. *Bithynia stenothyroides* : Hanley and Theobald, *Conch. Indica* : pl. 38, figs. 7 and 10.

1989. *Gabbia stenothyroides* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 77, figs. 143, 144.

Fig. 78. A. Dorsal view of *Gabbia stenothyroides* (Dohrn)

Fig. 78. B. Ventral view of *Gabbia stenothyroides* (Dohrn)

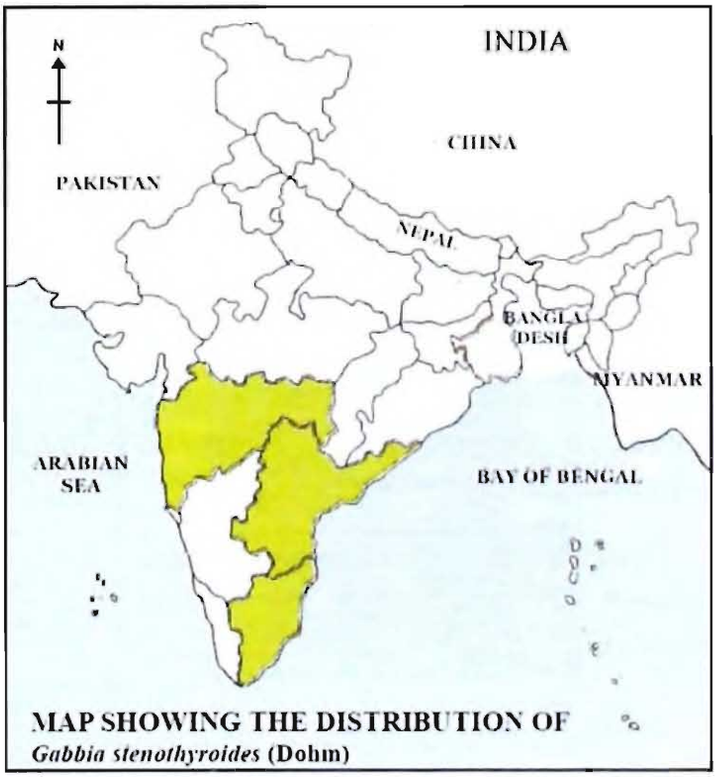
Type location : Not known.

Latest name and Reference : *Gabbia stenothyroides* : Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 194. *Zool. Surv. India.*

Diagnosis : Shell ovate, whorls 4-5, convex, smooth, body whorl proportionately larger, spire comparatively short, broadly conical, mouth somewhat contracted.

Distribution : India : Andhra Pradesh : Annantapur, Cuddapah, Hyderabad, Kurnool, Medak, Rangareddy; Maharashtra: Pune, Nilgiri, South Arcot; Tamil Nadu : Tiruchirapalli, Chennai;

Elsewhere : Sri Lanka.



MAP SHOWING THE DISTRIBUTION OF *Gabbia stenothyroides* (Dohrn)

Gabbia travancorica (Benson, 1860)

1860. *Bithynia travancorica* Benson, *Ann. Mag. Nat. Hist.*, (3)**6** : 259. (Type locality : Quilon).

1876. *Bithynia travancorica* : Hanley and Theobald, *Conch. Indica*, pl. 38, figs. 2, 3.

1989. *Gabbia travancorica* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 78, figs. 145-146.

Fig. 79. A. Dorsal view of *Gabbia travancorica* (Benson)

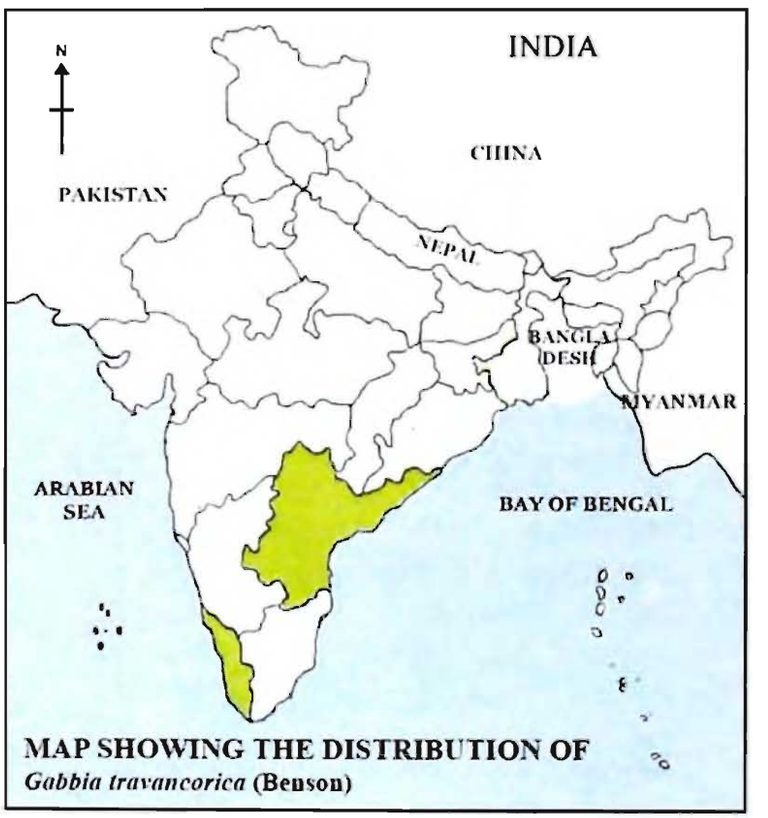
Fig. 79. B. Ventral view of *Gabbia travancorica* (Benson)

Type location : Cambridge University Museum, Cambridge.

Latest name and Reference : *Gabbia travancorica* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 195. *Zool. Surv. India.*

Diagnosis : Shell conically globose, whorls 4½, sutures impressed, imperforate, aperture oval, columellar margin ridge like.

Distribution : South India: Andhra Pradesh (Visakhapatnam) and Kerala (Quilon).



MAP SHOWING THE DISTRIBUTION OF *Gabbia travancorica* (Benson)

Genus ***Mysorella*** Annandale, 1919

1919. *Mysoria* Godwin-Austen, *Rec. Indian Mus.*, **16** : 211. (Preoccupied for Insecta, hence replacement name suggested.

1919. *Mysorella* : Godwin-Austen, *Rec. Indian Mus.*, **16** : 430. Type species : *Bithynia costigera* Kuester var *curta* Nevill.

Shell solid, ovately conical or depressedly conical with a large body whorl; spire moderately elevated; sculptured with three distinct spiral ribs above and two below the periphery; aperture sub circular and oblique, perforate, without any groove; columellar side thickened, peristome simple; operculum not very thick, calcareous, sub circular, concave, nucleus small with indication of spiral origin, internally convex and smooth. Central tooth of radula smaller and without basal denticulations

Southern Peninsular India and Sri Lanka.

Mysorella costigera (Kuester, 1852)

1852. *Paludina costigera* Kuester, In : Martini and Chemnitz, *Syst. Conch. Cab.*, **1**(21) : 33., pl. 7, figs. 18, 19. (Type locality : Bengal).

1915. *Bithynia* (? *Fossarulus*) *costigera* : Preston, *Fauna. Brit. India,* Mollusca (Freshwater Gastropoda and Pelecypoda), p. 78.

1989. *Mysorella costigera* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 84, fig. 124.

Type location : Not known.

Latest name and Reference : *Mysorella costigera* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 195. *Zool. Surv. India.*

Diagnosis : Shell ornamented by strongly raised spiral ridges weaker with finer and spiral ridges between them. Shell uniformly pale horny brown.

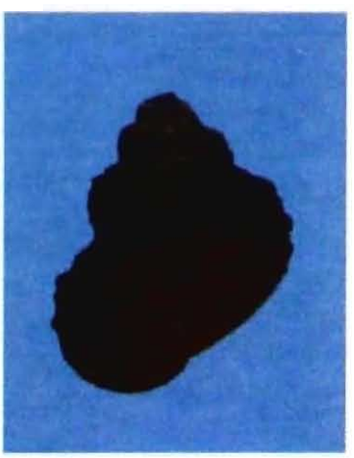


Fig. 80. A. Dorsal view of *Mysorella costigera* (Kuester)

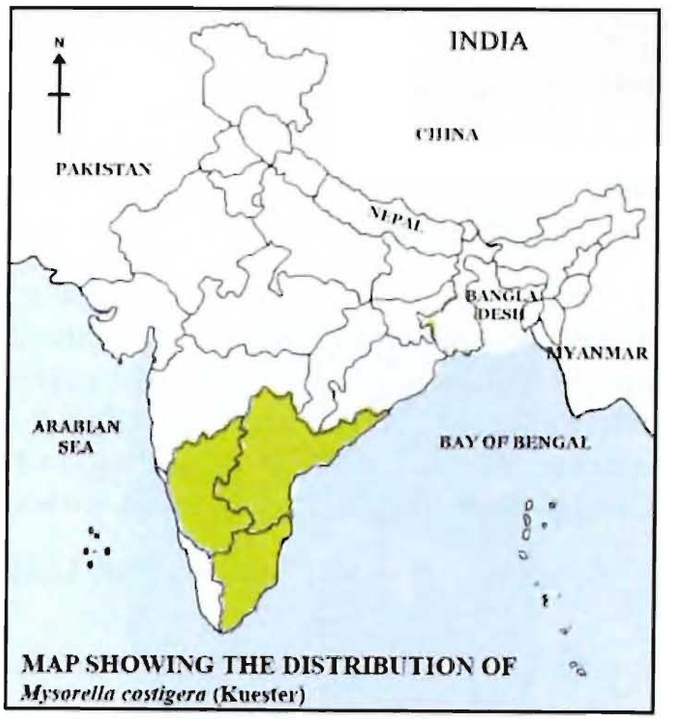
Fig. 80. B. Ventral view of *Mysorella costigera* (Kuester)

Distribution : India : Andhra Pradesh : Cuddapah, Madak; Karnataka, Pondicherry, Tamil Nadu.

Elsewhere : Sri Lanka.

Remarks : The type locality "bengal" as given by Kuester (1852) mentioned the type locality Bengal may be erroneous, as it does not occur in West Bengal.

Annandale (1920) mentioned two varities : i) The typical form occurring in muddy bottom in plains of Chennai and Sri Lanka; and ii) *curta* Nevill, a shorter shell than the typical form from Bangalore at an altitude of 3000 ft and above.



MAP SHOWING THE DISTRIBUTION OF *Mysorella costigera* (Kuester)

Godwin-Austen (1919) figured the type specimen along with operculum and radula from India, while Starmuehlner (1974) figured operculum and radula from species recorded from Sri Lanka and Seshaiya (1930) studied the anatomy of the species.

Family POMATIOPSIDAE

Family Pomatiopsidae includes the freshwater snails genus *Tricula* inhabiting in America and Europe and also found in the streams of Himalaya.

Subfamily TRICULINAE

Shell moderate or small (up to 10 mm), elongate with a number of whorls; operculum transparent, thin and paucispiral. Radula with broad denticulations; rachidian or central with 2-3 lateral denticulations on either side. Foot simple, undivided and produced anteriorly. Snout short and broad, tentacles filiform. Gill filaments prolonged across the roof of the mantle cavity to anal boarder. Verge without lateral appendages.

Found in mountain streams with shallow water attached to stones or weed.

India, China, Myanmar, Sri Lanka, Thailand.

Tribe **Triculini**

Genus ***Tricula*** Benson, 1843

1843. *Tricula* Benson, *Calcutta J. nat. Hist.*, **3** : 467. Type species : *Tricula montana* Benson.

Shell small, thin, elongate with smooth and glossy surface; perforate or imperforate; columellar callus not well developed; outer lip thin; aperture ovate to sub quadrate; operculum thin, horny and paucispiral.

Foot elongate, truncated anteriorly and rounded posteriorly; central tooth of radula without basal denticulations. Verge without lateral process.

Mountain streams of Central, North and North east India, Myanmar, South East Asia, Laos, Cambodia and Philippine.

Two species are reported from India.

Davis (1960, 1976, 1979, 1980) and Davis *et al.* (1983, 1984) made significant contributions about the anatomy of genus *Tricula.*

Key to the species

1. Aperture oval, outerlip irregularly thickened ..... *T. montana* Benson

– Aperture rounded, outerlip uniformly thickened ..... *T. gravelyi* Prashad

Tricula gravelyi Prashad, 1921

1921. *Tricula gravelyi* Prashad, *Rec. Indian Mus.* **22** : 39, figs: 1c, 1d. (Type locality : Still creek, amongst small islands in the bed of Narmada River, at Hoshangabad, Madhya Pradesh).

Type location : National Zoological Collection, ZSI, Regd. No. M 11895/2 (Syntypes).

Fig. 81. A. Dorsal view of *Tricula gravelyi* Prashad

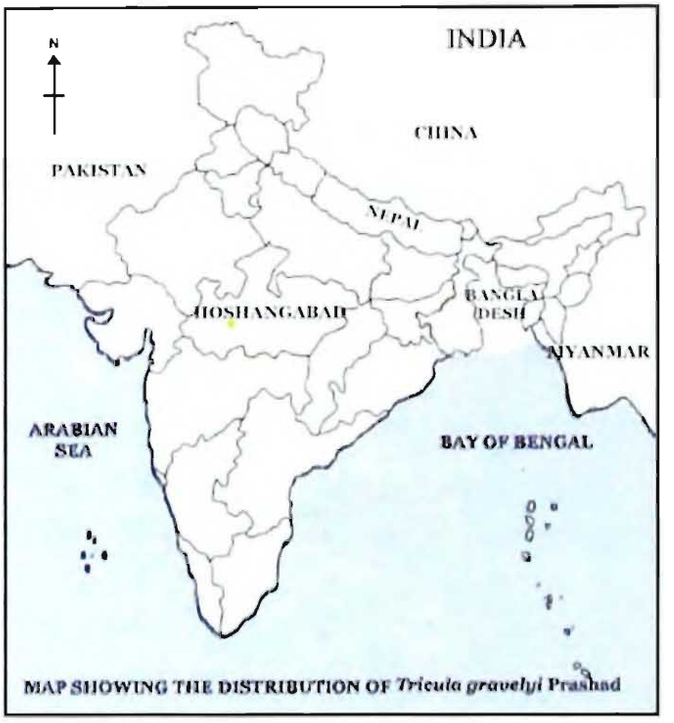
Fig. 81. B. Ventral view of *Tricula gravelyi* Prashad

Latest name and Reference : *Tricula gravelyi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 67, fig. 98.

Diagnosis : Shell elongate, oval, sub umbillicate or umbillicate, more than 1 to 2/3rd as long as broad; apex obtuse; whorls 5½ to 6½, increasing regularly, suture oblique, deep but not canaliculate, aperture oblique, ovate, and narrowly rounded above, smaller than in *T. montana*; peristome continuous; columellar lip thickened.

Found in the still creecks of the plains, attached on weeds.

Distribution : Not known beyond type locality.



MAP SHOWING THE DISTRIBUTION OF *Tricula gravelyi* Prashad

Tricula montana Benson, 1843

1843. *Tricula montana* Benson, *Calcutta J. nat. Hist.*, **3** : 467. (Type locality : Bhimtal, Nainital, Uttarakhand).

1921. *Tricula montana* : Prashad, *Rec. Indian Mus.*, **22** : 67, figs. 1a, 1b.

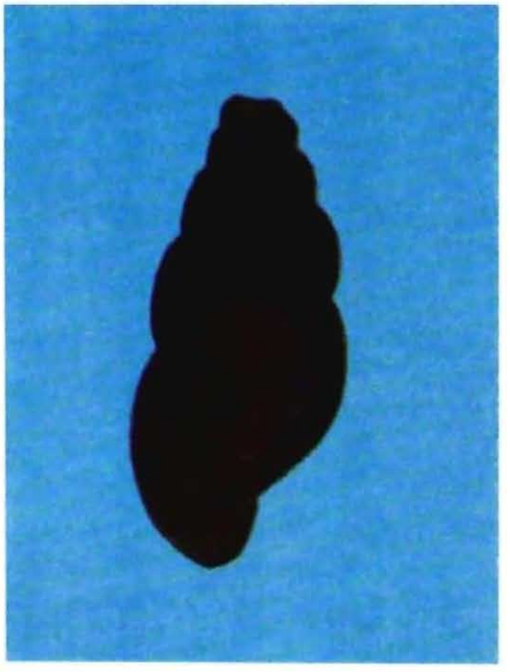


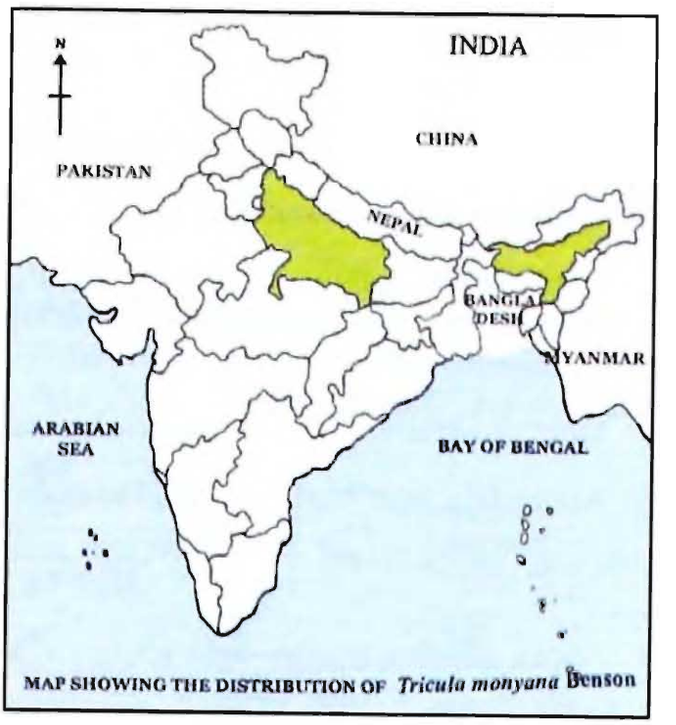
Fig. 82. A. Dorsal view of *Tricula gravelyi* Prashad

Fig. 82. B. Ventral view of *Tricula gravelyi* Prashad

Type location : Not known.

Latest name and Reference : *Tricula montana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 68, figs. 96, 97.

Diagnosis : Shell conically ovate, twice as long as broad, apex obtuse, whorls 5½ to 6, increasing irregularly but not very tumid; sutures oblique, curved and somewhat canaliculated; body whorl very tumid, 2½ times as broad as penultimate whorl; aperture large, oblique, ovoid, pointed above and has part of the peristome curved over its angle; peristome continuous; columellar callus narrow and unequal; light olive in colour.



MAP SHOWING THE DISTRIBUTION OF *Tricula monyana* Benson

Found on the stems and leaves of aquatic plant in the stream floating through marsh at Bhimtal Lake.

Distribution : India : Assam, Uttarakhand : Bhimtal.

Elsewhere : Central Sri Lanka.

Family STENOTHYRIDAE

Shell small, dextral (upto 5 mm), subcylindrical or ovate, compressed on dorso-ventral axis. Whorls convex, bodywhorl more or less descending to the small, subcircular aperture. Sculpture smooth but often ornamented umbilicate or imperforate; operculum horny or calcareous, paucispiral, internally with two prominent trasnseverse ridges. Foot long and narrow, spindle shaped, anteriorly truncate and posteriorly pointed. Radula 2-1-1-1-2.Teeth relatively broader, marginal and laterals are less differentiated. Rostrum cylindrical, extremely mobile and extensile. Tentacles filiform, eyes on slightly raised bases. Penis cylindrical and without a lateral process.

India, Iran to Indonesia, Australia to Philippines, Japan and Western Pacific Islands. Mainly estuarine only a few of them represented from freshwater.

Annandale and Prashad (1921) treated this family as a subfamily of Hydrobiidae.

Key to the genera

1. Mouth small, not prominent, separated from the outer edge of shell above by a defined triangular area ..... ***Stenothyra*** Benson

– Mouth large and prominent, separated from the outer edge of shell by a small ill defined area ..... ***Gangetia*** Ancey

Genus *Stenothyra* Benson, 1856

1856. *Stenothyra* Benson, *Ann. Mag. nat. Hist.*, **18** : 496. Type species : *Nematura deltae* Benson, 1836.

Shell small, ovate or subcylindrical, thick; whorls 4-6; sculpture with minute punctuated spiral lines; aperture subcircular or oval, peristome continuous; operculum horny, brittle, internally with two transverse ridges or smooth, conevex and polished.

India, Australia, China, Formosa, Japan, Malay Archipelago, Myanmar and Philippine.

Annandale and Prashad (1921) revised this genus.

Key to the species

1. Shell bearing microscopic sculpture and spiral rows of spines on the whorls .... *S. ornata* Annandale and Prashad
– Shell without microscopic sculpture or any spines on whorls ..... (2)
2. Shell almost cylindrical, elongate by elongately ovate..... *S. hungerfordiana* Nevill
– Shell ovoid or ovate .....(3)
3. Aperture less than 1/3rd of the body whorl .....(4)
– Aperture more than 1/3rd of the body whorl .....(7)
4. Shell with definite spiral pitted sculpture .....(5)
– Shell without any spiral pitted sculpture ..... *S. woodmasoniana* Nevill
5. Shell minute (2 mm long), spire short with bluntly rounded apex .... *S. nana* Prashad
– Shell relatively large (more than 2 mm long), spire conical with acuminated apex .....(6)
6. Shell ovate, acute, body whorl smaller and not greatly swollen .... *S. fovelata* Benson
– Shell globose, conical, body whorl large and swollen ..... *S. deltae* (Benson)
7. Shell globose, thick, with a small boss separating the mouth from body whorl .... *S. soluta* Annandale and Prashad
– Shell not globose, with a well developed boss separating mouth from body whorl .....(8)
8. Shell elongately ovate, spire more produced, spiral whorl increasing regularly, aperture nearly circular, body whorl less tumid, with a faint notch above..... ..... *S. minima* (Sowerby)

– Shell subventricose, ovate, spire short, spiral whorls increasing irregularly, body whorl swollen, aperture biangulate, suboval ..... *S. blanfordiana* Nevill

Stenothyra blanfordiana Nevill, 1880

1880. *Stenothyra blanfordiana* Nevill, *J. Asiat. Soc. Beng.*, **49(2)** : 160. (Type locality : Chilka Lake, Orissa).

1914. *Stenothyra chilkaensis* : Preston, *Rec. Indian Mus.*, **10** : 300, fig. 1. (Type locality : Barkul, Chilka Lake).

1915. *Stenothyra obesula* : Preston, *Rec. Indian Mus.*, **11** : 292, fig. 4. (Type locality : Southern most Islands of Manikpatna, Chilka Lake).

1921. *Stenothyra blanfordiana* : Prashad, *Rec. Indian Mus.*, **22** : 129.

Type location : National Zoological Collection, ZSI, Regd. No. M 11888/2 (Syntypes)

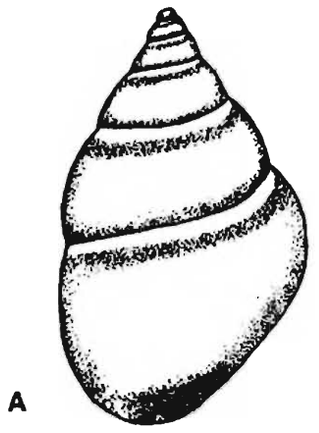


Fig. 83. A. Dorsal view of *Stenothyra blanfordiana* Nevill (Holotype)

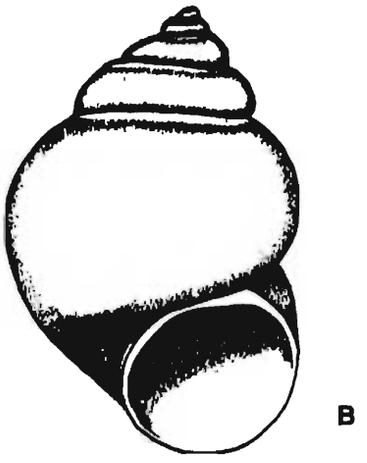


Fig. 83. B. Ventral view of *Stenothyra blanfordiana* Nevill (Holotype)

Latest name and Reference : *Stenothyra blanfordiana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 87. figs. 149, 150, 159, 160.

Diagnosis : Shell subventricose, spire not much elongated; whorls 4½, increase irregularly, body whorl tumid and subangulate; operculum oval, semi-transparent, spire of a few whorls, nucleus central, with three ridges on the inner side, one semicircular and two short ones with a single S-curvature.

Distribution : India : Orissa : Chilka Lake; Tamil Nadu : Chennai; West Bengal : Port Canning.

Stenothyra deltae (Benson, 1836)

1836. *Nematura deltae* Benson, *J. Asiat. Soc. Beng.*, **5** : 782. Type locality : Gangetic Delta.

1921. *Stenothyra deltae* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 131, text fig.2.

Fig. 84. A. Dorsal view of *Stenothyra deltae* (Benson)

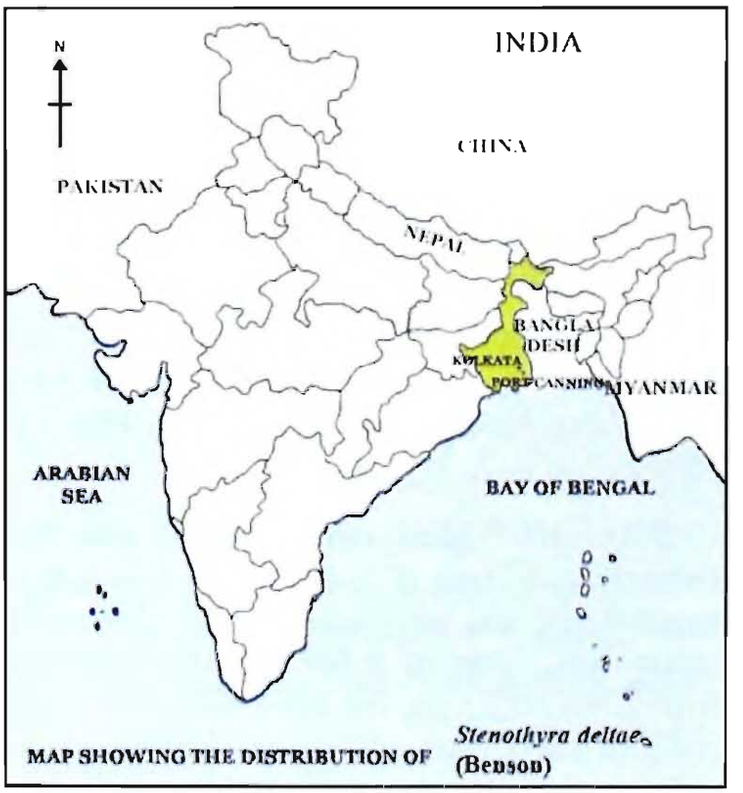
Fig. 84. B. Ventral view of *Stenothyra deltae* (Benson)

Type location : Natural History Museum, London.

Latest name and Reference : *Stenothyra deltae* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 87, fig. 166a.

Diagnosis : Shell small, comparatively thick, with ventrally flattened body whorl : sculpture with spiral punctured lines; aperture small, subcircular with merely the trace of a notch above; periostracum thick and often with spiral rows of spines.

Found crawling on the mud at the upper region of bank of river.



MAP SHOWING THE DISTRIBUTION OF *Stenothyra deltae* (Benson)

Distribution : India : West Bengal: 24 Paraganas (North & South), Kolkata : Chandpal Ghat.

Stenothyra foveolata Benson, 1856

1856. *Stenothyra foveolata* Benson, *Ann. Mag. nat. Hist.*, **(2)17** : 497. (Type locality : in Gange fluvio, prope Sikrigali).

1876. *Stenothyra foveolata* : Hanley and Theobald, *Conch. Indica* : pl. 37, fig., 3.

1921. *Stenothyra foveolata* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 132.

Fig. 85. A. Dorsal view of *Stenothyra foveolata* Benson

Fig. 85. B. Ventral view of *Stenothyra foveolata* Benson

Type location : Not known.

Latest name and Reference : *stenothyra foveolata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 88.

Diagnosis : Shell ovately conical with acute apex; whorls 5, convex; sutures shallow; sculpture with spiral pits or punctate markings; aperture oblique ovate.

Distribution : India : Bihar: Ganges near Sikrigali, Bhagalpur; West Bengal.

Stenothyra hungerfordiana Nevill, 1880

1880. *Stenothyra hungerfordiana* Nevill, *J. Asiat. Soc. Beng.*, **49**(2) : 159. Type locality : Andamans.

1881. *Stenothyra hungerfordiana* : Nevill, *J. Asiat. Soc. Beng.*, **50** : 156, pl. 7, fig. 9.

1921. *Stenothyra hungerfordiana* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 127.

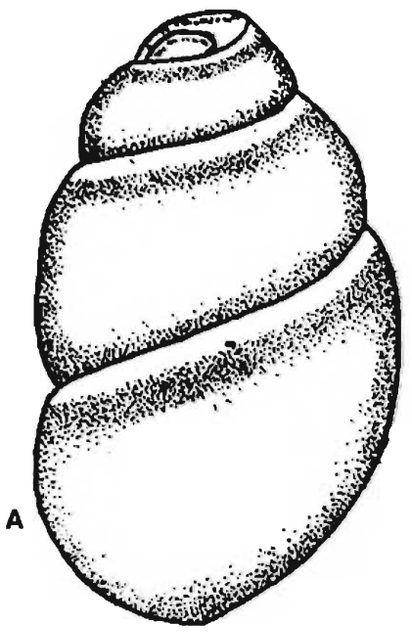


Fig. 86. A. Dorsal view of *Stenothyra hungerfordiana* Nevill (Holotype)

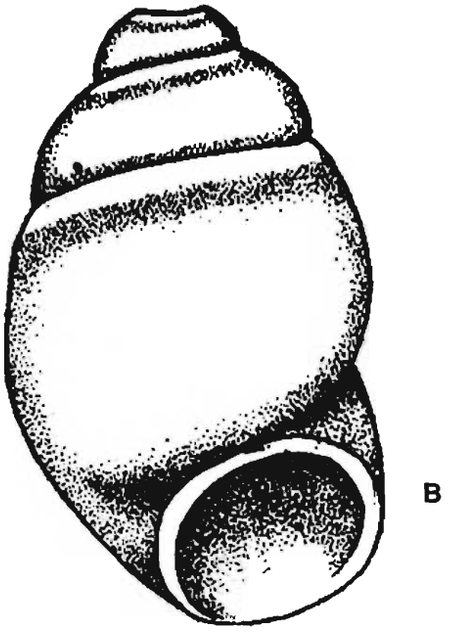


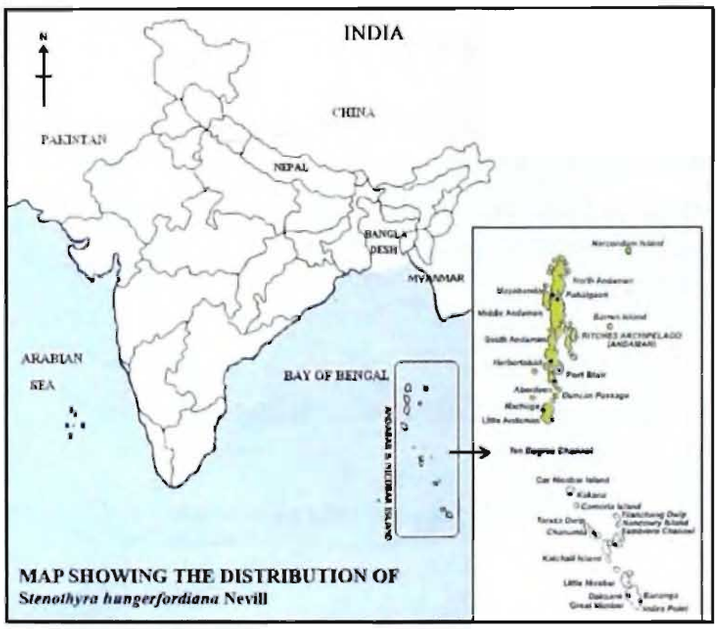
Fig. 86. B. Ventral view of *Stenothyra hungerfordiana* Nevill (Holotype)

Type location : National Zoological Collection, ZSI, Regd. No. M 16906/2 (Holotype).

Latest name and Reference : *Stenothyra hungerfordiana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 88, figs.165, 166.

Diagnosis : Shell small, ovately turbinate, perforate, apex obtuse, body whorl remarkably long, compressed, slightly flattened and ovate, whorls convex; sculpture with minute, distinct, close punctations; suture distinct, and on the body whorl distinctly marginate below.

Distribution : India : Andaman only.



Stenothyra minima (Sowerby, 1837)

1837. *Nematura minima* Sowerby, *Ann. Mag. nat. Hist.* (Charlesworth's series) **1** : 217, fig. 22b. (Type locality : Western India).

1914. *Stenothyra orissaensis* : Preston, *Rec. Indian Mus.*, **10** : 300, fig. 2. (Type locality : Chilka, Orissa).

1921. *Stenothyra minima* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 129.

Fig. 87. A. Dorsal view of *Stenothyra minima* (Sowerby)

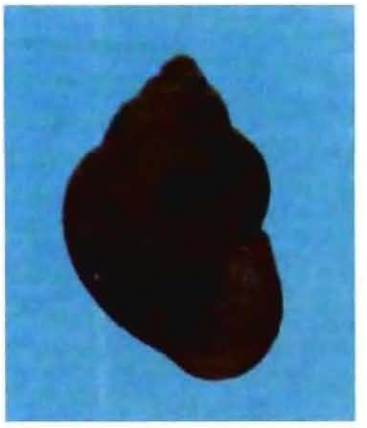


Fig. 87. B. Ventral view of *Stenothyra minima* (Sowerby)

Type location : Natural History Museum, London.

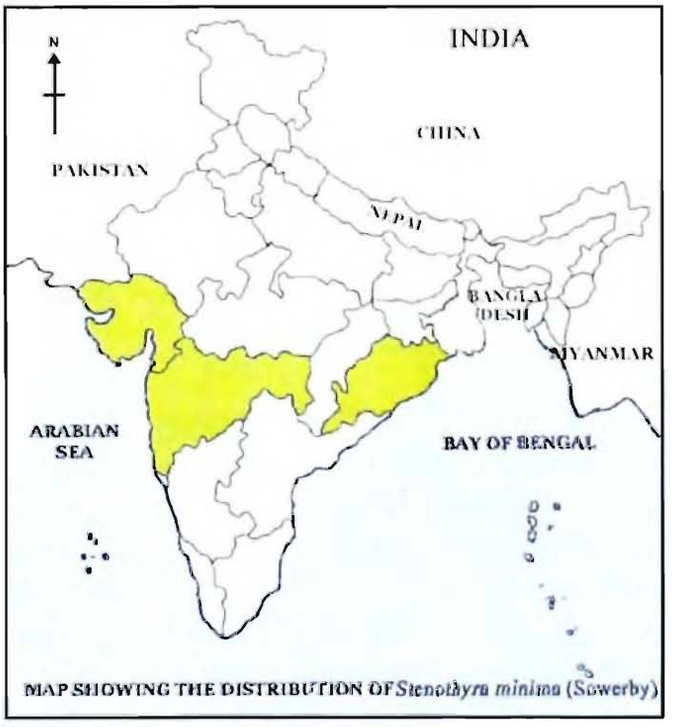
Latest name and Reference : *Stenothyra minima* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 89, figs. 151-154, 163, 164.

Diagnosis : Shell small, ovately turbinate, narrowly perforate, whorls 5, smooth, regularly increasing, body whorl convex and rapidly descending in front.

Closely resembles with *S. blanfordiana* Nevill but can be distinguished from it by the regularly increasing spiral whorls.

Distribution : India : Gujarat : Kathiawar; Maharashtra : Mumbai; Orissa : Chilka Lake.

Elsewhere : Sri Lanka.



MAP SHOWING THE DISTRIBUTION OF *Stenothyra minima* (Sowerby)

Stenothyra nana Annandale and Prashad, 1921

1921. *Stenothyra nana* Annandale and Prashad, *Rec. Indian Mus.*, **22** : 130, pl. 16, figs. 5, 6. Type locality : Chandpal, Calcutta.

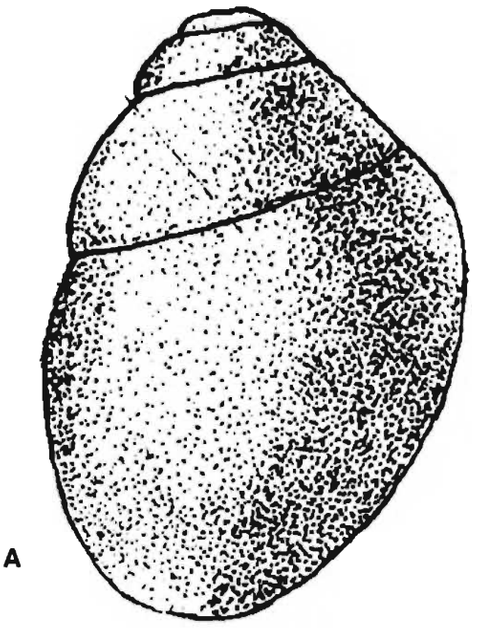


Fig. 88. A. Dorsal view of *Stenothyra nana* Prashad

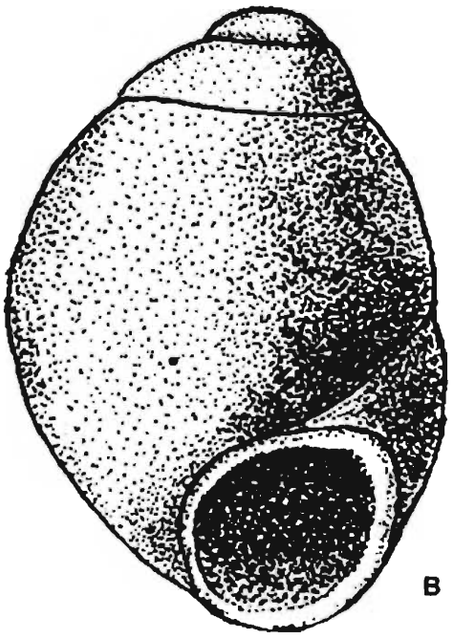


Fig. 88. B. Ventral view of *Stenothyra nana* Prashad

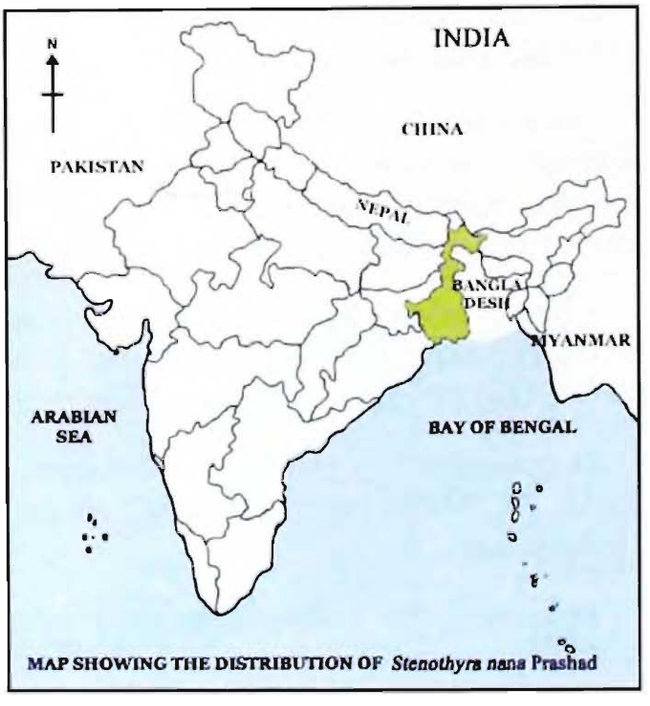
Type location : National Zoological Collection, ZSI Regd. No. M 2196.

Latest name and Reference : *Stenothyra nana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 89, figs. 169, 170.

Diagnosis : Shell ovately conical, imperforate; whorls 4, increasing very rapidly, suture faintly impressed, regular and somewhat oblique, body whorl large, subrhomboidal in dorsal view, but nearly flat in the anterior 2/3 of its length ventrally, with prominent boss or lamellae.

Distribution : India : West Bengal : Kolkata : Chandpal Ghat.

Elsewhere : Ranong harbour, Thailand (Brandt, 1974).



Stenothyra ornata Annandale and Prashad, 1921

1921. *Stenothyra ornata* Annandale and Prashad, *Rec. Indian Mus.*, **22** : 126, pl.16, figs. 1, 2. (Type locality : Brackish water pool at Dhapa near Calcutta).

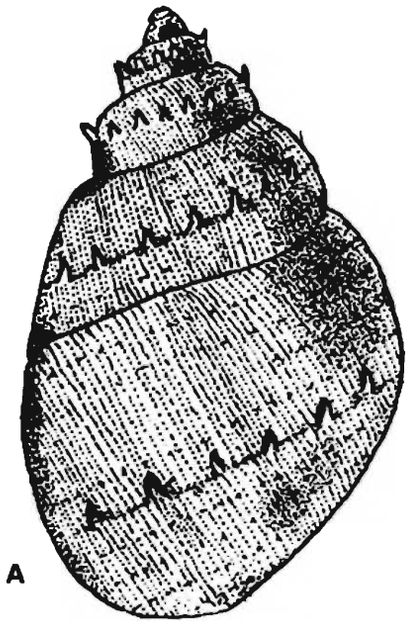


Fig. 89. A. Dorsal view of *Stenothyra ornata* Annandale and Prashad (Holotype)

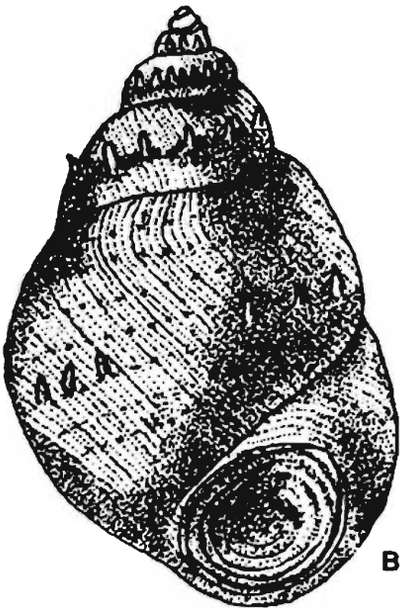


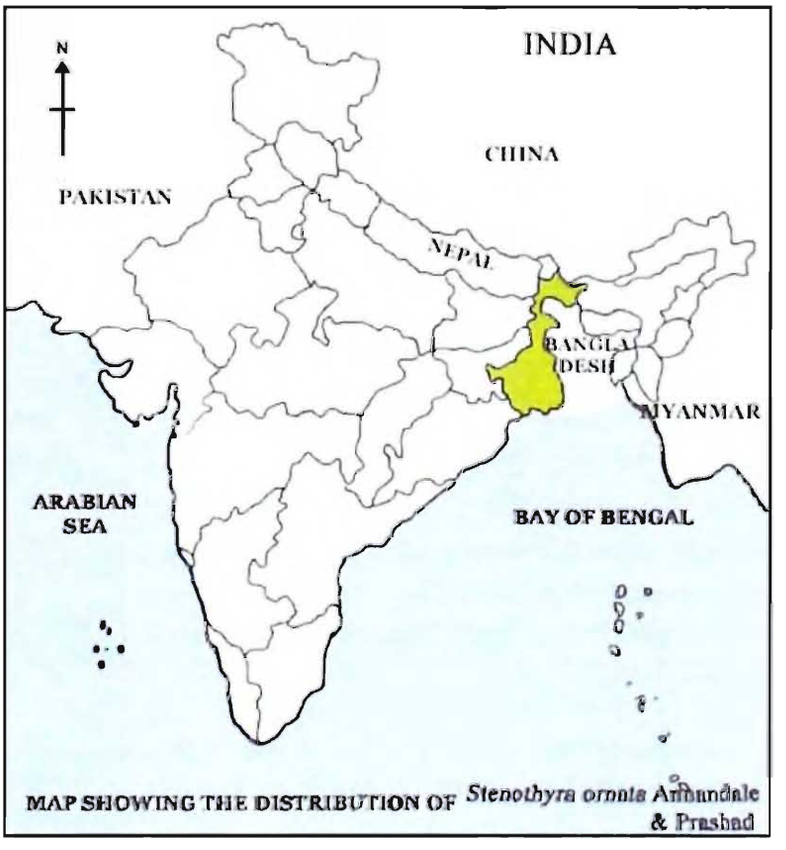
Fig. 89. B. Ventral view of *Stenothyra ornata* Annandale and Prashad (Holotype)

Type location : National Zoological Collection, ZSI Regd. No. M 11565/2.

Latest name and Reference : *Stenothyra ornata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 89, figs. 169, 170.

Diagnosis : Shell imperforate, ovately conical; apex acute, pointed; whorls 5½, spiral whorls distinctly keeled in the middle, keel continues to the body whorl, on last 4 whorls with spiral rows of blunt, flattened, blackish spines.

Distribution : India : West Bengal : Kolkata.



Stenothyra soluta Annandale and Prashad, 1919

1919. *Stenothyra soluta* Annandale and Prashad, *Rec. Indian Mus.*, **16** : 247, pl. 20, fig. 6. (Type locality : A creek in the Gangetic Delta of Basanti).

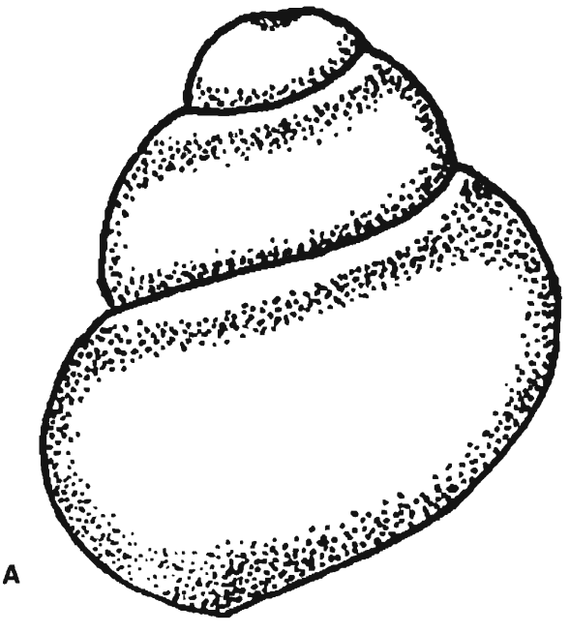


Fig. 90. A. Dorsal view of *Stenothyra soluta* Annandale and Prashad (Holotype)

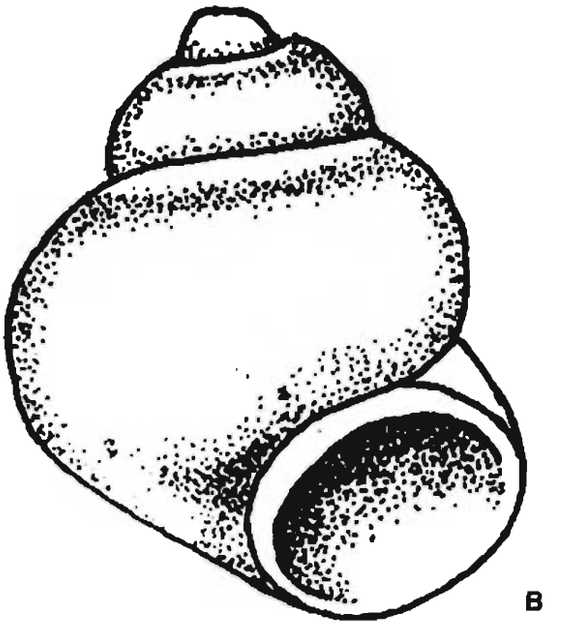


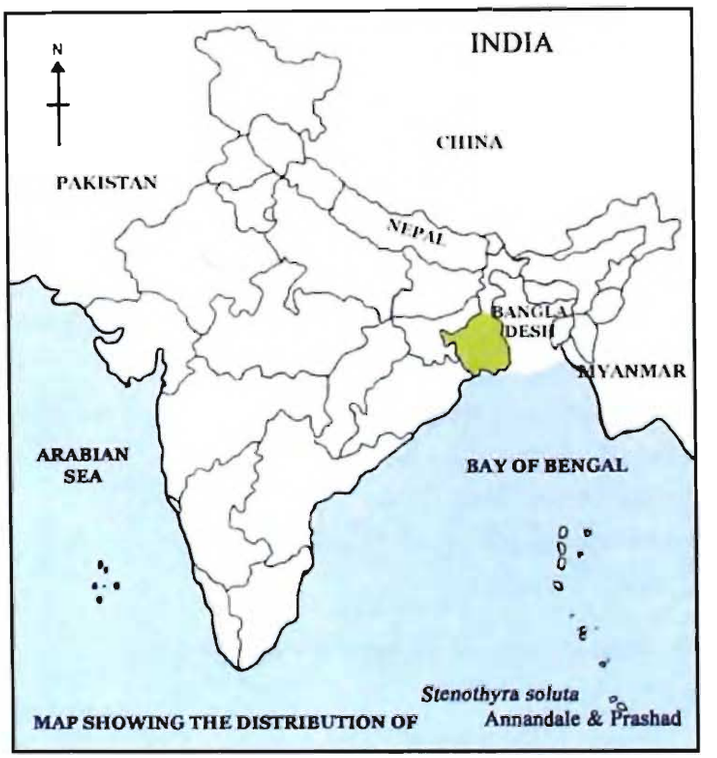
Fig. 90. B. Ventral view of *Stenothyra soluta* Annandale and Prashad (Holotype)

Type location : National Zoological Collection, ZSI, Regd. No. M 11442/2.

Latest name and Reference : *Stenothyra soluta* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 90, figs. 173, 174.

Diagnosis : Shell thick, globose, with flattened spire, concave at the apex; whorls distinct and swollen; body whorl proportionately short, stout, not flattened on the ventral surface; aperture large, oval, rounded posteriorly, very prominent; peristome thick and somewhat plicated concentrically.

Distribution : India : West Bengal : Gangetic Delta. It is a brackish water species.



Stenothyra woodmasoniana Nevill, 1880

1880. *Stenothyra woodmasoniana* Nevill, *J. Asiat. Soc. Beng.*, **49**(2) : 159. (Type locality : Port Canning). 1881. *Stenothyra* Woodmasoniana Nevill, *J. Asiat. Soc. Beng.*, **50**(2) : 156, pl. 7, fig. 8.

Fig. 91. A. Dorsal view of *Stenothyra woodmasoniana* Nevill

Fig. 91. B. Ventral view of *Stenothyra woodmasoniana* Nevill

Type location : National Zoologica Collection, ZSI Regd. No. M 2197.

Latest name and Reference : *Stenothyra woodmasoniana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 90 figs.161, 162.

Diagnosis : Shell ovately conical, spire acute, concavely excavated, whorls 5-6, body whorl subangulate, flattened with rounded umbilical region; sculpture smooth or may appear malleated under large magnification.

Distribution : India : West Bengal Gangetic Delta.

Genus *Gangetia* Ancey, 1890

1890. *Gangetia* Ancey, *Bull. Soc. Malacol. Fr.*, **7** : 162. Type species : *Hydrobia (Belgrandia) miliacea* Nevill

1921. *Astenothyra* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 133 (as Subgenus). Type species : *Hydrobia (Belgrandia) miliacea* Nevill.

Shell minute (upto 5 mm), ovate or subcylindrical; body whorl convex; aperture larger than in the genus *Stenothyra,* ovate and prominent; triangular area between aperture and outer edge of body whorl absent.

India, Gulf of Oman, Myanmar.

Gangetia miliacea (Nevill, 1880)

1880. *Hydrobia (Belgrandia) miliacea* Nevill, *J. Asiat. Soc. Beng.*, **49**(2) : 161. (Type locality : Port Canning, West Bengal).

1921. *Stenothyra (Astenothyra) miliacea* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 134, text fig. 3.

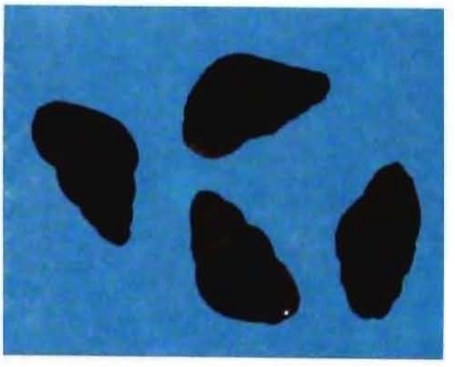


Fig. 92. *Gangetia miliacea* (Nevill)

Type location : National Zoological Collection, ZSI Regd. No. M 11865/2.

Latest name and Reference : *Gangetia miliacea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 91, figs. 155, 156, 175-182.

Diagnosis : Annandale and Prashad (1921) recognised three varieties namely, f. *typica*, var. *subangulata* Prashad and var. *gibbosula* Prashad. In the typical form aperture is evenly rounded and body whorl is smooth. The body whorl is distinctly keeled in var. *gibbosula* whereas it is smooth in *subangulata*. The latter can however be differentiated from the typical form by its subangulate aperture.

Distribution : India : Kerala : Cochin Backwater; Orissa, West Bengal : Gangetic delta.

Elsewhere : Gulf of Oman.

Family IRAVADIIDAE

Shell medium larger than in genus *Tricula;* whorls with strong spiral ridges; aperture oval, peristome thick and with an external varix; columellar margin weak; operculum horny, nucleus nearer to the inner margin, two transverse ridges on the inner sides.

Central teeth of radula short and broad, with additional cusps on the either sides of basal corners; lateral long.

Mostly an estuarine family found in India and Myanmar.

Genus *Iravadia* Blanford, 1867

1867. *Iravadia* Blanford, *J. Asiat. Soc. Beng.*, **36**(2) : 56. Type species : *Iravadia ornata* Blanford

Shell thick, imperforate and turreted with spiral ridges and covered with periostracum aperture oval.

Four species were described by Preston from India and all are known by their types only. Brackish water.

Key to the species

1. Shell fusiform, whorls less than 5 ..... *I. funerea* Preston

– Shell elongated, whorls 5 or more ..... (2)

2. Sculptured with indistinct, irregular, spiral lirae, interstices, not deep, transverse striae obsolete ..... *I. annandalei* Preston

– Sculptured with distinct, regular spiral lirae, interstices crossed by transverse striae ..... (3)

3. Spire very much pointed, lower margin of columella produced *I. princeps* Preston

– Spire less pointed, lower margin of columella not produced .. *I. ennurensis* Preston

Iravadia annandalei Preston, 1916

1916. *Iravadia annandalei* Preston, *Rec. Indian Mus.*, **12** : 31, figs., 8, 8a. (Type locality : Ennur back waters).

Fig. 93. A. Dorsal view of *Iravadia annandalei* Preston

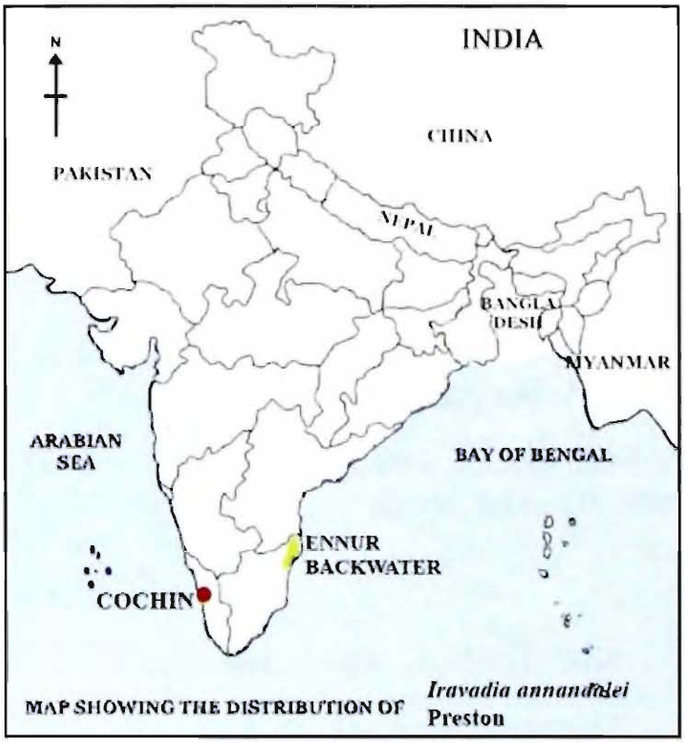
Fig. 93. B. Ventral view of *Iravadia annandalei* Preston

Type location : National Zoological Collection, ZSI Regd. No. M 10051/2 (Holotype)

Latest name and Reference : *Iravadia annandalei* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 70, figs. 105, 106.

Diagnosis : Shell small, cylindrically fusiform; whorls 6; suture impressed; sculpture with microscopic transverse striae; aperture smaller and the labrum quite continuous.

Differs from *ennurensis* by its more slender form, acute lirations and obsolete, transverse striae; body whorl six; aperture smaller.



Distribution : India : Kerala : Cochin; Tamil Nadu : Ennur backwater.

Iravadia ennurensis Preston, 1916

1916. *Iravadia ennurensis* Preston, *Rec. Indian Mus.*, **12** : 31, figs. 7, 7a. Type locality : Ennur backwater, Madras (Chennai).

Fig. 94. A. Dorsal view of *Iravadia ennurensis* Preston

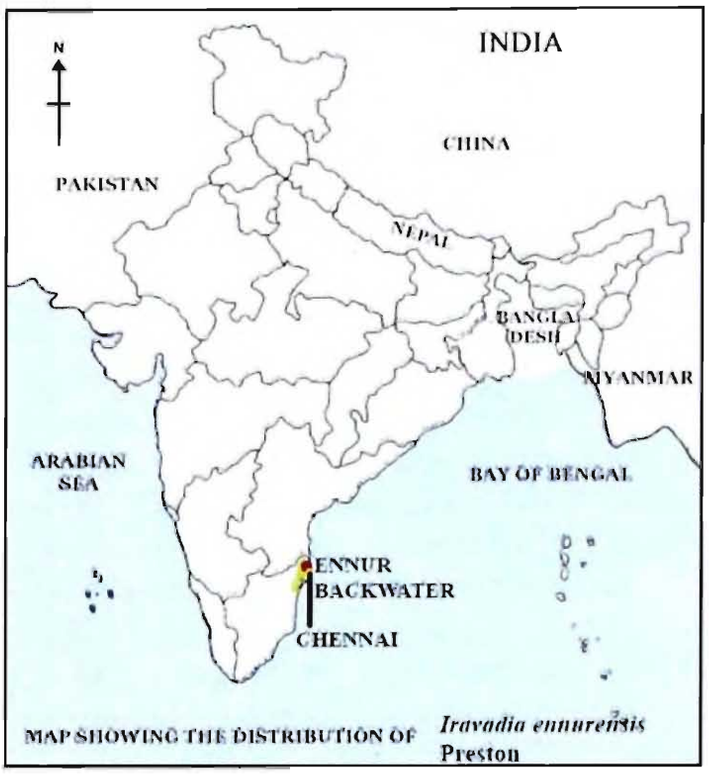
Fig. 94. B. Ventral view of *Iravadia ennurensis* Preston

Type location : ZSI Regd. No. M 10050/2 (Holotype)

Latest name and Reference : *Iravadia ennurensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 71, figs. 107, 108.

Diagnosis : Shell small, cylindrically fusiform, imperforate; whorls five; sculptured with regular revolving spiral lirae crossed by fine transverse striae; suture impressed, finely lirate above; columellar margin slightly oblique, defused above into a thick, restricted and well defined, parietal callus united at upper margin of labrum; yellowish white in colour.

Distribution : India : Tamil Nadu : Ennur back water, Chennai.



Iravadia funerea Preston, 1916

1916. *Iravadia funerea* Preston, *Rec. Indian Mus.*, **12** : 30, figs. 6, 6a. (Type locality : Cochin backwater, near Ernaculum).

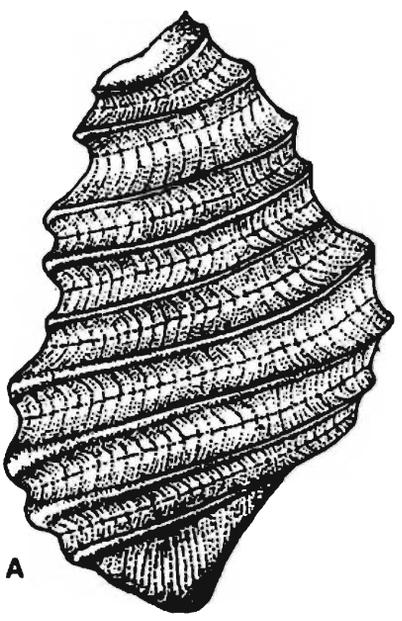


Fig. 95. A. Dorsal view of *Iravadia funerea* Preston (Holotype)

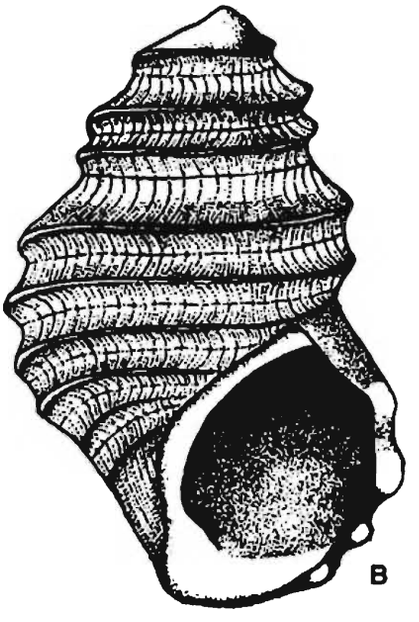
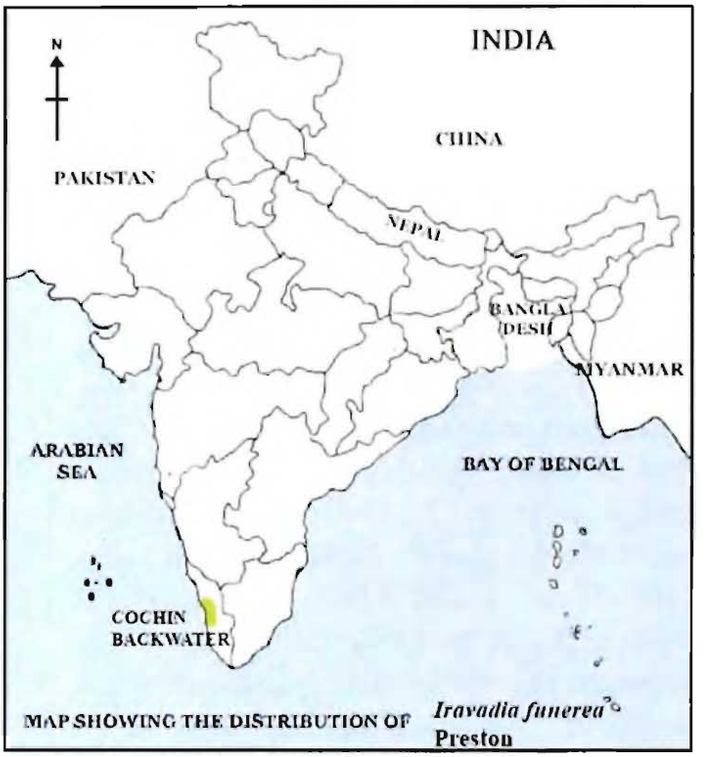


Fig. 95. B. Ventral view of *Iravadia funerea* Preston (Holotype)

Type location : National Zoological Collection, ZSI Regd. No. M 10052/2 (Holotype)

Latest name and Reference : *Iravadia funerea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 71, figs. 109, 110.

Diagnosis : Shell, ovately fusiform, small, covered with greyish black periostracum; whorls 3, sculptured with coarse spiral lirae showing traces of transverse striations; suture impressed; columellar margin vertically descending, diffused above into a very restricted, well defined parietal callus which joins with the upper margin of labrum; labrum acute; aperture slightly oblique and elliptical.



Distribution : India : Kerala : Cochin backwater.

Iravadia princeps Preston, 1915

1915. *Iravadia princeps* Preston, *Rec. Indian Mus.*, **11** : 480, figs. 2, 2a. (Type locality : Canal near Chingrighatta, outskirts of Calcutta)

Fig. 96. A. Dorsal view of *Iravadia princeps* Preston

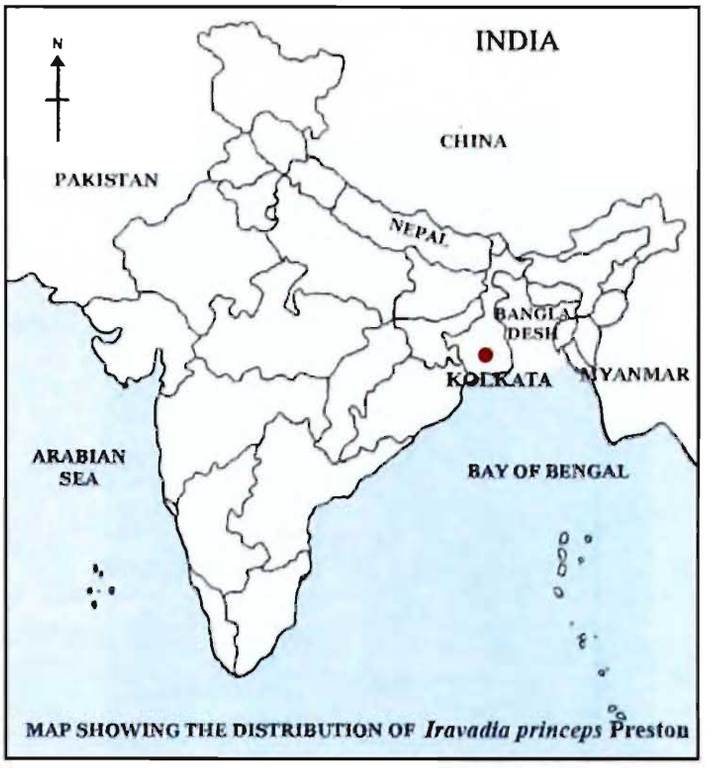
Fig. 96. B. Ventral view of *Iravadia princeps* Preston

Type location : National Zoological Collection, ZSI, Regd. No. M. 9741 (Holotype)

Latest name and Reference : *Iravadia princeps* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 71, figs. 111, 112.

Diagnosis : Shell elongately fusiform, imperforate; whorls seven, flat, smooth; suture impressed; sculpture with fine, acute, regular and slightly distant spiral lirae, interstices occupied by very fine transverse riblets; columellar margin porcellanous, narrowly expanded outward and reflexed, continous with labrum; aperture broadly ovate, a little oblique.

Distribution : India : West Bengal : Out skirts of Kolkata.



MAP SHOWING THE DISTRIBUTION OF *Iravadia princeps* Preston

Family ASSIMINEIDAE

Shell small, dextral varying in shape, conical or globose, depressed including a cup like form. Operculum paucispiral and corneous. Tentacles are reduced to short lobes containing eyes. Central teeth with or without basal denticles; a characteristics acessory plate lies between the lateral and first marginal teeth. Oviparous some may be viviparous and properly parthenogenetic. Copulatory organ lacks acessory lobe.

Cosmopolitan. Found in brackishwater and freshwater near coasts. Abundant in tropical regions and many of them are amphibious.

Subfamily ASSIMINEINAE

Genus ***Assiminea*** Flemming, 1828

1828. *Assiminea* Flemming in Sowerby and Gray, *British An.*, : 27. Type species : *Assiminea grayana* Flemming.

Shell small up to (10 mm), conical or globose, smooth or with spiral ridges; operculum paucispiral, corneous; Tentacles are reduced to short lobes containing eyes; radula consist of a central tooth with or without basal denticles, a characteristic accessory plate lies between the lateral and first marginal teeth.

Assiminea francessi (Wood, 1828)

1828. *Turbo franceisi* Gray, in Wood's *Index Test. Suppl.*, taf. 6, fig., 28.

Fig. 97. A. Dorsal view of *Assiminea francessi* (Wood)

Fig. 97. B. Ventral view of *Assiminea francessi* (Wood)

Type location : Not known.

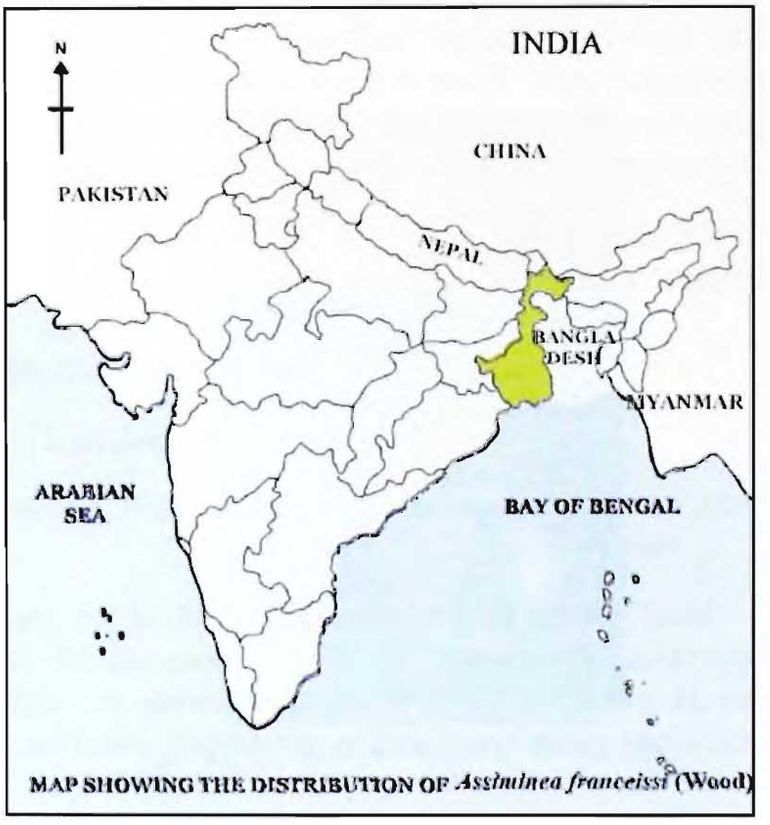
Latest name and Reference : *Assiminea francessi* : Mitra and Dey, 1992, *Fauna of West Bengal, State Fauna Series,* 3(Part-9), p. 18. *Zool. Surv. India.*

Diagnosis : Shell elongate, apex pointed, whorls seven, rapidly increasing in width; aperture oblique, ovate.

It is the only species occurs in fresh water ponds, canals having link with the Hugli river and extends further north.

Distribution : India : West Bengal.

Elsewhere : Bangladesh, Myanmar.



MAP SHOWING THE DISTRIBUTION OF *Assiminea franceissi* (Wood)

Superfamily CERITHIOIDEA

Family THIARIDAE

Small to large, dextral, elongate, turreted to ovate-conical to elongate, generally with the spire higher than aperture, thick walled. Whorls rounded with moderate or impressed suture. Smooth or variously sculptured with ridges, ribs, nodules, spines, knobs or tubercles, imperforate. Aperture ovate or pear shaped, sometimes rather canaliculate. Operculum corneous, paucispiral, multispiral or concentric with spiral nucleus.

Animal with broad, bifurcated and laterally keeled snout, foot small and squarish. Eyes as short stalks near the external base of tentacles. Mantle margin smooth or papillate. Radula 2-1-1-1-2, cutting edges of teeth with few or numerous cusps.

Commonly oviparous, but some have a uterine brood pouch or a seaprate brood pouch in the neck. In some groups males are unknown and the female is parthenogenetic. The largest family of Indian freshwater prosobranchs, prefers streams or rivers, also found in stagnant ponds or lakes etc.

World wide. Common on tropical and temperate regions.

Important contributions to this group includes Annandale (1920) revision of genera; Brot (1874) systematics; Jacob (1953, 1958, 1959) cytology; Muley (1975-1978) physiology; Nagabhushanam and Kulkarni (1972) physiology; Nagabhushanam and Muley (1974, 1975, 1977) neurosecretion; Natarajan (1968) cytology, Ramamoorthi (1949, 1950, 1955) embryology; Seshaiya (1929, 1934, 1935, 1936) anatomy.

Morrison (1954) contributed on reproductive system of the group were not accepted by Binder (1959) and Mandahl-Brorth (1967).

Subfamily THIARINAE

Shell imperforate, ovately conical to elongate-turreted shape, smooth or spirally sculptured, tuberculate or spiny; aperture elongatly-ovate, angular above; operculum paucispiral, with a basal nucleus.

Mantle fringed with finger like processes; central tooth of radula lacking a process below the crown; female is parthenogenetic with a brood pouch in the neck separate from the uterus, males are unknown.

Africa, Asia, Central and South America, Pacific and Caribbean Islands.

Key to the genera

1. Shell with sinus in upper and lower corner of aperture ..... ***Faunus*** Montfort

– Shell without sinus in upper and lower corner of aperture ..... (2)

2. Spire exceeding the height of body whorls; sculpture with axial and spiral ridges or striae but without spines ..... (3)

– Spire not exceeding the height of body whorl; sculpture with conspicuous nodules, granules or axial ridges ..... (4)

3. Shell not much elongated, not very slender, whorls less than 12; sculpture with spiral striae crossed by axial striae ..... ***Melanoides*** Oliver

– Shell very much elongated, very slender, whorls more than 12; sculpture with spiral striae only ..... ***Stenomelania*** P. Fischer

4. Shell granulose or tessellated with nodules or with contrasting sculpture on body whorls round between suture and the periphery, spiral whorls gradually increasing ..... ***Tarebia*** H. and A. Adams

– Shell spinous or sharply nodulose, whorls angular between suture and the periphery, spiral whorls descending pagoda like ..... ***Thiara*** Roeding

Genus ***Thiara*** Roeding, 1798

1798. *Thiara* Roeding. *Mus. Bolten.*, 2 : 109. Type species : *Helix amarula* Linnaeus, 1758.

Shell medium to large, elongate with a high spire; number of whorls varies from 8 to 15; suture deep or shallow; sculpture variable with transverse ribs which tend to project as spines; aperture more or less vertical without any sinus or siphonal canal; aperture pear shaped, with a concentric nucleus at the narrow, basal end.

Mantle edge bears 10 to 14 papillae. Male unknown. Female are viviparous.

Found in freshwaters of tropical and subtropical parts of Africa and Asia.

Key to the subgenera

1. Body whorl with axial ridges on the upper region strongly contrasting with spiral ridges of its lower part ..... ***Sermyla*** H. and A. Adams

– Body whorl with conspicuous nodules, granules or axial ridges ..... ***Thiara*** s. st.

Subgenera ***Thiara*** s. st.

Key to the species

1. Whorls descending step like, spines present below the suture ..... (2)

– Whorls regularly increasing; sculptured with axial ribs and strong spiral ridges..... .....*T. rudis* (Lea)

2. Shell with spiral ridges, spire almost equal to the body whorl *T. scabra* (Mueller)

– Shell almost smooth, spire shorter than body whorl.....*T. amarula* (Linnaeus)

Thiara (Thiara) amarula (Linnaeus, 1758)

1758. *Helix amarula* Linnaeus, *Syst. Nat.* ***ed.*10** : 774. (Type locality : Rivers in Asia).

1976. *Thiara amarula* : Starmuehlner, *Ann. Natur. Hist. Mus. Wien.* **80** : 558, figs. 63-66, pl. 15, fig. 166.

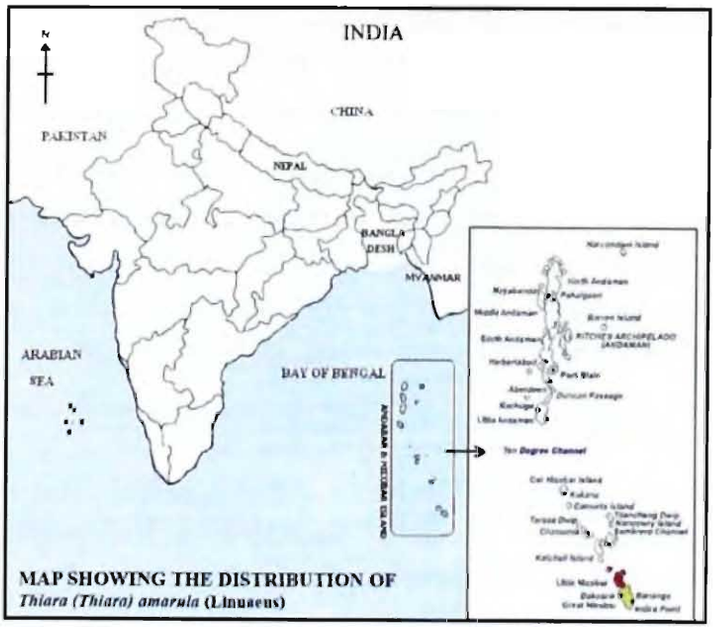
Fig. 98. A. Dorsal view of *Thiara (Thiara) amarula* (Linnaeus)

Fig. 98. B. Ventral view of *Thiara (Thiara) amarula* (Linnaeus)

Type location : Not known.

Latest name and Reference : *Thiara (Thiara) amarula* : Subba Rao, 1989. *Handbook of Freshwater Molluscs of India*, p. 97, figs. 203-204.

Diagnosis : Shell large, dark brown, spire decollated, body whorl longer than the spire; body whorl with crown of spines near the periphery and suture, project upwards from shoulder, strong spiral sculpture confined to the base of the shell; mantle edge bears 15-25 papillae.



Only females are known (Starmuehlner, 1969).

Distribution : India : Great Nicobar.

Elsewhere : Fiji, Indonesia : Amboina, Java, Sumatra; Malagasy, Mauritius, Natal, New Caledonia, Philippines.

Thiara (Thiara) rudis (Lea, 1850)

1850. *Melania rudis* Lea, *Proc. zool. Soc. Lond.*, **1850** : 186. (Type locality : Amboina).

1956. *Thiara rudis* : Benthem Jutting, *Treubia*, **23**(2) : 389, fig. 83.

Fig. 99. A. Dorsal view of *Thiara (Thiara) rudis* (Lea)

Fig. 99. B. Ventral view of *Thiara (Thiara) rudis* (Lea)

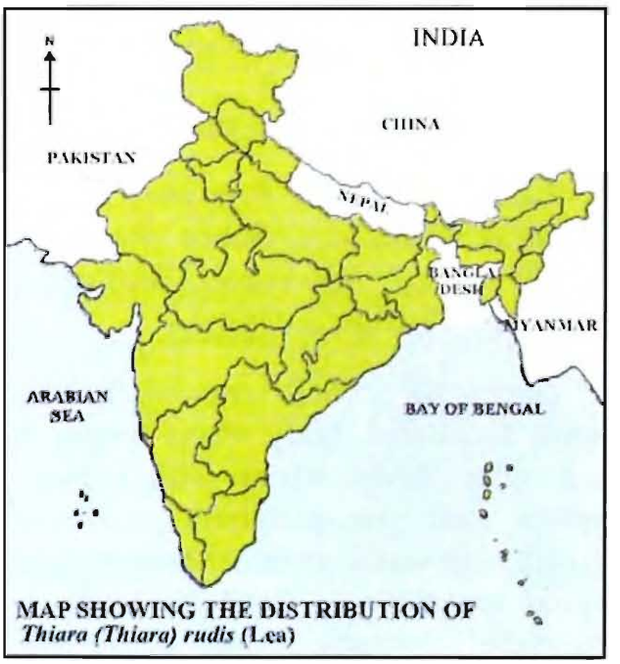
Type location : AMNH

Latest name and Reference : *Thiara (Thiara) rudis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 97, fig. 199.

Diagnosis : Shell thick, sub cylindrical; spire high; sculpture with axial ribs and spiral ridges forming nodules; sometimes strongly developed subsutural nodules just below the suture, spiral ridges often in beaded form.

Distribution : India.

Elsewhere : Indonesia : Amboina, Batjan, Halnahera, Java, Sumatra; Kampuchia, Myanmar, Philippines, Sri Lanka.



MAP SHOWING THE DISTRIBUTION OF *Thiara (Thiara) rudis* (Lea)

Thiara (Thiara) scabra (Mueller, 1774)

1774. *Buccinum scabrum* Mueller, *Hist. Verm. Terr. Fluv.* **2** :136. Type locality : Tranquebar.

1850. *Melania acanthica* : Lea, *Proc. zool. Soc. Lond.*, **1850** : 194.

1973. *Thiara (Thiara) scabra* : Pace, *Malac. Review Suppl.*, **1** : 52, pl.12, figs. 1, 2, pl. 13.

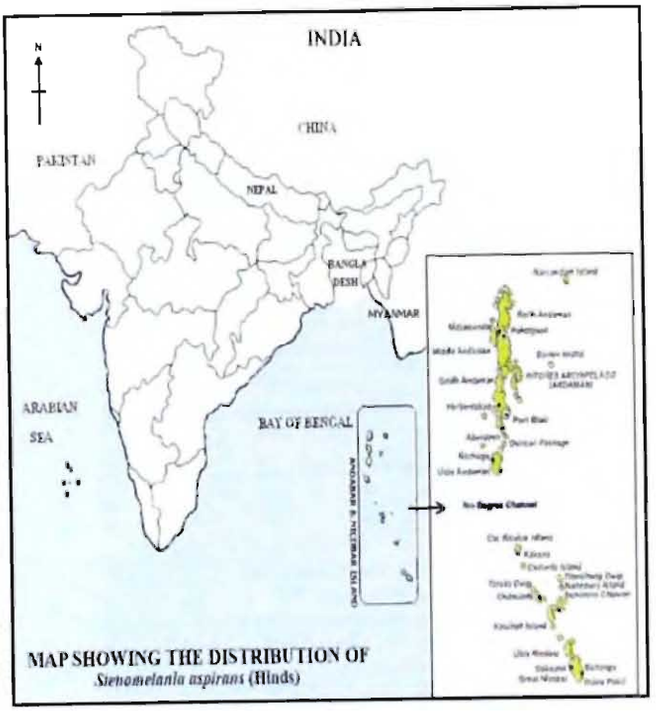
1989. *Thiara (Thiara) scabra* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 96, figs. 185, 186, 189.

Fig. 100. A. Dorsal view of *Thiara (Thiara) scabra* (Mueller)

Fig. 100. B. Ventral view of *Thiara (Thiara) scabra* (Mueller)

Type location : Not known.

Latest name and Reference : *Thiara (Thiara) scabra* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, 5(Part-5), p 195. *Zool. Surv. India.*



Diagnosis : Shell elongate, turreted whorls regularly increasing in size; spire as high as body whorl; sutures distinct, whorls often shouldered above and rounded below the row of spines; sculptured with vertical ribs bearing prominent spines directed obliquely outward, surface with rough spiral striations, on the body whorl near the umbilical region striations form strong ridges, pale brown in colour.

Prefers slow moving water. Occurs in slow or fast moving water as well as stagnant water.

Distribution : India : Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Pondichery, Tamil Nadu, West Bengal : Kolkata, Bardhaman, Hugli, Midnapore, 24 Paraganas (North).

Elsewhere : Indonesia : Java, Japan, Malaya Archipelago, Mauritius, Myanmar, Philippines, Seychelles, Timor.

Subgenus *Sermyla* H. and A. Adams, 1854

1854. *Sermyla* H. and A. Adams, *Gen. Rec. Moll.*, **1** : 296. Type species : *Melania tornatella* Lea, 1850.

Shell with shorter spire than body whorl, arcuate, axial ridges on the upper region strongly contrasting with the spiral ridges on the basal part of body; aperture vertical, pointed above and rounded below.

Thiara (Sermyla) riqueti (Grateloup, 1840)

1840. *Melania requeti* Grateloup, *Act. Soc. Linn. Bordaeux,* **11** : 433, pl.3, fig. 28. Type locality : Bombay (Mumbai).

1973. *Thiara (Melanoides) riqueti* : Pace, *Mal. Riview Supplement,* **1** : 64, pl. 12, fig., 4, pl. 13, fig. 5.

Type location : Not known.

Latest name and Reference : *Thiara (Sermyla) riqueti* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 102, fig. 190.

Fig. 101. A. Dorsal view of *Thiara (Sermyla) riqueti* (Grateloup)

Fig. 101. B. Ventral view of *Thiara (Sermyla) riqueti* (Grateloup)

Diagnosis : Shell small, elongate; whorls eight, regularly increasing; suture distinct; sculpture with undulating axial and spiral ridges, axial ridges dominant above the periphery and the spiral ridges below it on the body whorl.

Distribution : India : Kerala : Cochin, Quilon and Trivandrum; Maharashtra : Mumbai.

Elsewhere : South East Asia, Australia, China, Japan : Ryukyu Islands; Malaysia, Philippines, and Taiwan.

Genus ***Faunus*** Montfort, 1810

1810. *Faunus* Montfort, *Conch. Syst.* **2** : 427. Type species : *Strombus ater* Linnaeus, 1758.

Shell elongated with a long spire; Whorls several, flat, finely striated spirally and axially.Aperture oval, anterior canal present at the base and posterior with a sinus; Columella arched, smooth, excentric nucleus.

India, Malay Archipelago, New Hebrides, New Guinea, Philippines and Sri Lanka.

Only one species represented from India.

Faunus ater (Linnaeus, 1758)

1758. *Strombus ater* Linnaeus, *Syst. Nat.* ed. **10** : 746. (Type locality : Asiae paludibus).

1956. *Faunus ater* : Benthem Jutting, *Treubia*, **23**(2) : 380, fig. 78.

Fig. 102. A. Dorsal view of *Faunus ater* (Linnaeus)

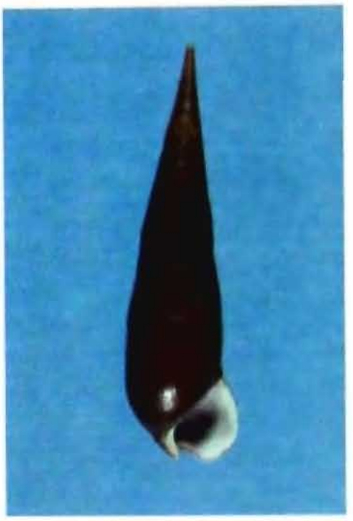


Fig. 102. B. Ventral view of *Faunus ater* (Linnaeus)

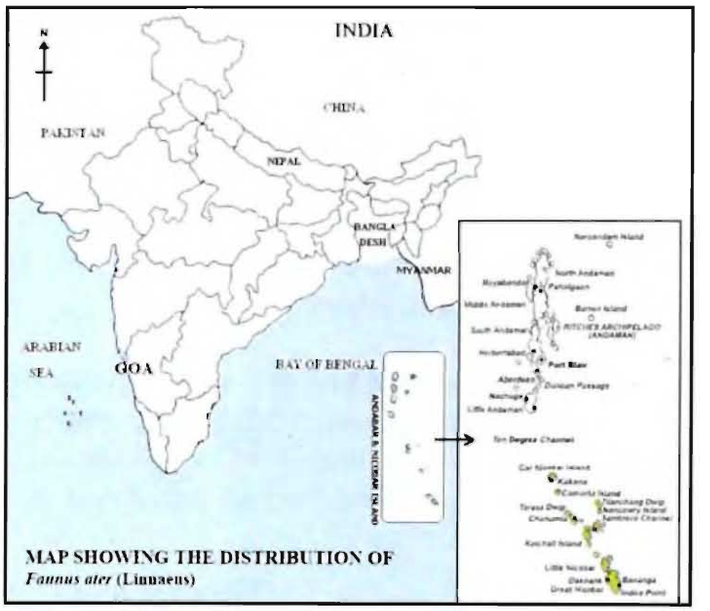
Type location : Not known.

Latest name and Reference : *Faunus ater* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 109, figs. 208, 209.

Diagnosis : Shell with a long spire; whorls flat, 18 to 20 regularly increasing, the first 5 or 6 whorls strongly striated; sutures shallow; aperture broadly oval with sinus at upper and lower ends.

Occurs in slightly brackish water.

Distribution : India : Goa, Nicobar Islands.



MAP SHOWING THE DISTRIBUTION OF *Faunus ater* (Linnaeus)

Elsewhere : Malay Archipelago, Mauritius, New Guinea, New Ireland, Philippines, Sri Lanka.

Genus ***Melanoides*** Olivier, 1804

1804. *Melanoides* Olivier, *Voyage a l 'Emp. Ottoman*, **2** : 40. Type species : *Melanoides fasciolata* Olivier = *Nerita tuberculata* Mueller, 1774.

Shell medium to large, upto 50 mm in high with a number of regular increasing whorls; spire high and slender, usually twice the length of the aperture or more; sculptured with transverse and spiral striae, commonly forming tubercles; aperture small, ovoid and not greatly produced in front; columella slightly bent and not produced anteriorly; operculum relatively large, paucispiral, posterior extremity pointed, basal nucleus approaching sub spiral condition.

Viviparous and parthenogenetic.

Found in freshwater and brackish water within a large range including eastern Pacific Islands, Southern Asia, most of Africa.

Key to the species

1. Sculpture with raised spiral ridge ..... (2)

– Sculpture without raised spiral ridges ..... (3)

2. Sculpture stronger on upper whorl; Outer lip not curved at upper angle .... *M. tuberculata* (Mueller)

– Sculpture uniformly strong throughout the shell; Outer lip curved at upper angle . ..... *M. peddamunigalensis* Ray and Roy Chowdhury

3. Sculpture almost smooth, spiral striae on upper whorls .....*M. nicobarica* (Nevill)

– Sculpture with spiral and axial striae throughout or partly .....(4)

4. Shell sculptured partly with spiral striae on lower portion of whorl and well developed on upper whorls .....*M. nevillei* (Brot)

– Shell sculptured uniformly ..... *M. crebra* Lea

Melanoides crebra Lea, 1850

1850. *Melania crebra* Lea, *Proc. zool. Soc. Lond.*, **1850** : 193. Type locality : Philippines.

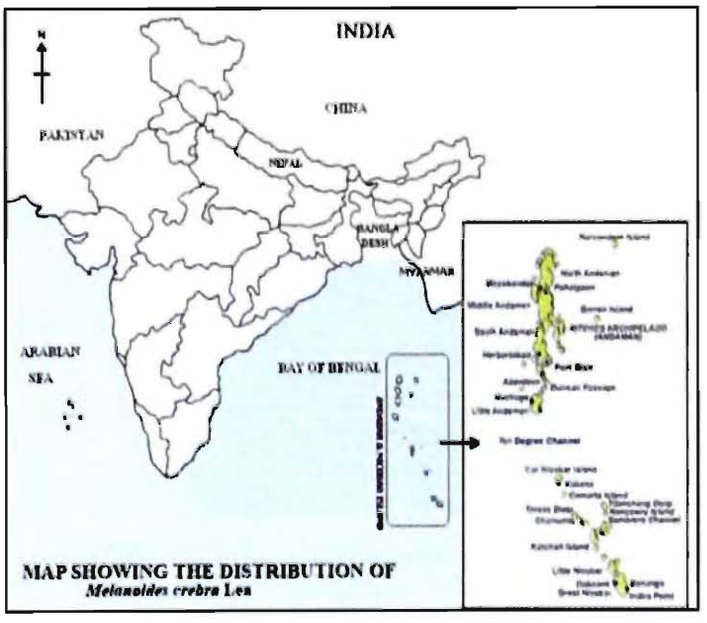
Fig. 103. A. Dorsal view of *Melanoides crebra* Lea

Fig. 103. B. Ventral view of *Melanoides crebra* Lea

Type location : Not known.

Latest name and Reference : *Thiara (Melanoides) tuberculata crebra* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 105, figs. 187, 188, 195, 196.

Diagnosis : It differs from the typical form in being broader, width usually more than 1/3rd of the total height whorls comparatively less rounded; sculpture; with broad equidistant spiral ridges, raised axial ridges present only on the apical whorls often continuing on the body whorl.



Distribution : India : Andaman and Nicobar Islands.

Elsewhere : Philippines; Prepari Island; Bay of Bengal (Preston, 1915).

Melanoides nevilli (Brot, 1874)

1874. *Melania nevilli* Brot, *Conch. Cab.*, **11** : pl. 22, fig. 13.

1884. *Melania (Striatella) nevilli* var. *andamanica* Nevill, *Handlist Moll. Indian Mus.*, **2** : 296. Type locality : Andaman.

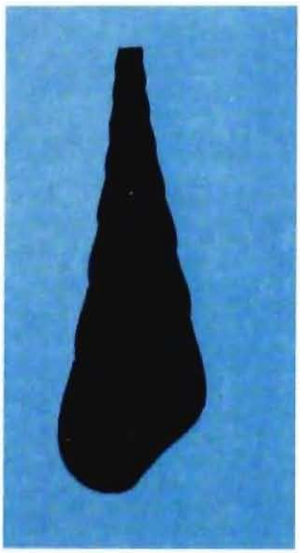


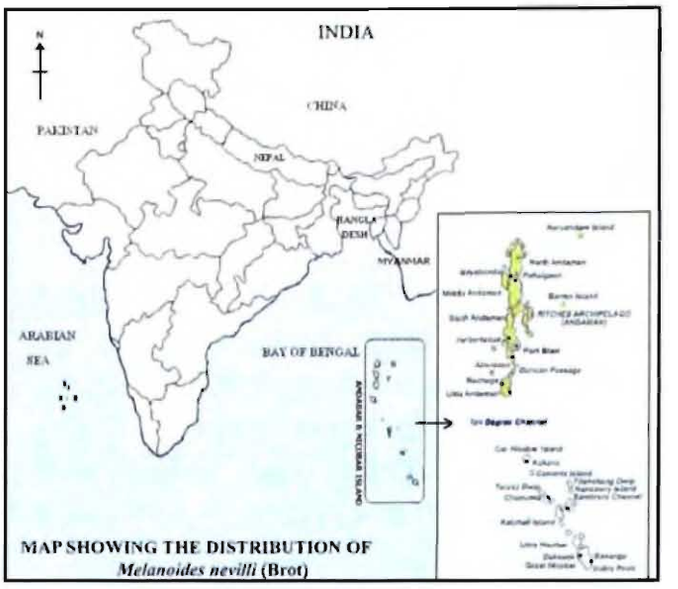
Fig. 104. A. Dorsal view of *Melanoides nevilli* (Bort)

Fig. 104. B. Ventral view of *Melanoides nevilli* (Bort)

Fig. 105. A. External view of *Melanoides nevilli* var. ***andamanica*** Nevill

Fig. 105. B. Internal view of *Melanoides nevilli* var. ***andamanica*** Nevill

Type location : National Zoological Collection, ZSI, Regd. No. M 16910/2 (Holotype, *Melania nevilli* var. *andamanica*).



Latest name and Reference : *Melanoides nevilli* (Brot) : Subba Rao, Das and Mitra, 1980. *Rec. zool. Surv. India*, **77** : 234, pl. Ii, fig. 9.

Diagnosis : Shell elongated, turreted with long a spire; suture depressed; whorls 7-8, upper 3-4 logitudinally ribbed, ribs not so prominent but distinctly arcuate and obsolete on the lower portion of the last whorl; sculpture with spiral stirae throughout, obsolete on central portion on last 2-3 whorls; aperture pyriform; shell covered with a rust brown coating, colour light green with irregular brown spots below the suture.

Distribution : India : Andaman Islands.

Elsewhere : Tahiti.

Melanoides nicobarica (Moerch, 1859)

1859. *Melania nicobarica* Moerch in Reeve, *Conch. Icon.*, **12** : *Melania* sp. no 54, pl. 10, fig. 54. Type locality : Nicobar.

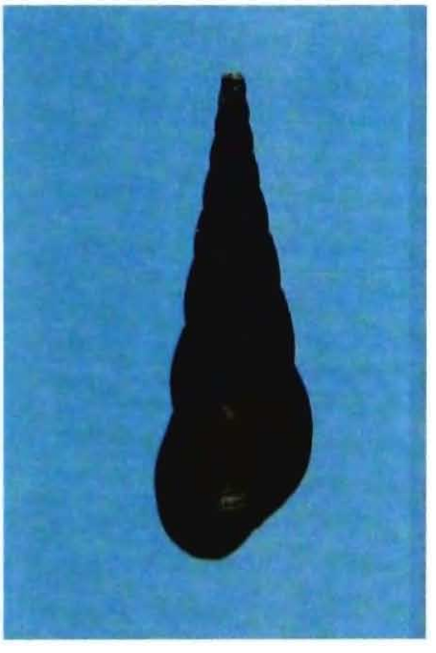


Fig. 106. A. Dorsal view of *Melanoides nicobarica* (Moerch)

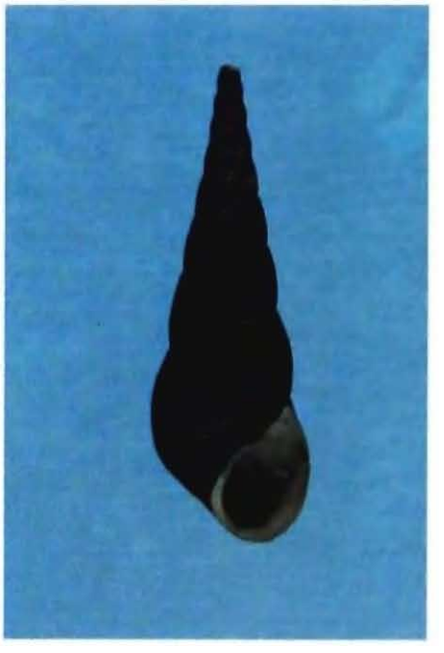


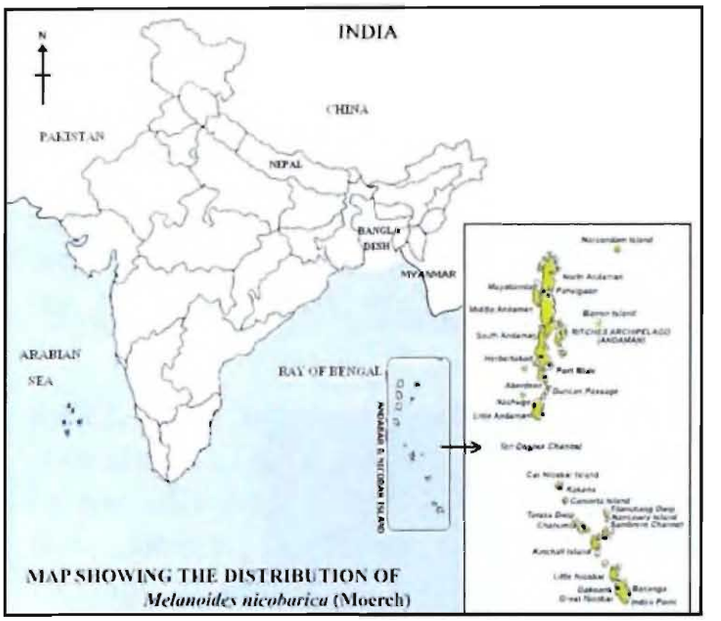
Fig. 106. B. Ventral view of *Melanoides nicobarica* (Moerch)

Type location : Not known.

Latest name and Reference : *Melanoides nicobarica* : Subba Rao, Das and Mitra, 1980, *Rec. zool. Surv. India*, **77**, p. 234, pl. 2, fig. 10.

Diagnosis : Shell elongate, solid, turriculated; whorls 10-12, rounded, the first spirally grooved throughout, the rest with upper and lower grooves fading away; suture deep; body whorl with infrasutural ridge; aperture small; black in colour.

Distribution : India : Andaman and Nicobar Islands.



Melanoides peddamunigalensis Ray and Roy Chowdhury

1969. *Melanoides (Melanoides) peddamunigalensis* Ray and Roy Chowdhury, *Proc. zool. Soc., Calcutta*, **22** : 48, figs. 12-17. Type locality : Peddamunigal, Nalgonda, Andhra Pradesh.

Type location : National Zoological Collection, ZSI, Regd. No., M 18070/3 (Holotype) and M 18071/3 (Paratype).

Fig. 107. A. Dorsal view of *Melanoides peddamunigalensis* Ray and Roy Chowdhury

Fig. 107. B. Ventral view of *Melanoides peddamunigalensis* Ray and Roy Chowdhury

Latest name and Reference : *Melanoides peddamunigalensis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 197. *Zool. Surv. India.*

Diagnosis : Shell narrowly elongate with a long tapering spire, apex pointed, whorls evenly rounded, suture deep, coarsely sculptured with vertical ribs and spiral striae; vertical ribs more pointed on body whorl; aperture ovate, outer lip strongly arched forming a curve at upper angle.

Distribution : India : Andhra Pradesh : Nalgonda; Tamil Nadu.

Melanoides tuberculata (Mueller, 1774)

1774. *Nerita tuberculata* Mueller, *Hist. Verm. Terr. Fluv.*, **2** : 191. Type locality : Coromandel Coast.

1936. *Melania pyramis* : Benson, *J. Asiat. Soc. Beng.*, **5** : 354. (Type locality : Ganges).

1976. *Melanoides (Melanoides) tuberculata* : Starmuehlner, *Ann. Natur. Hist. Mus. Wien.*, **80** : 591.

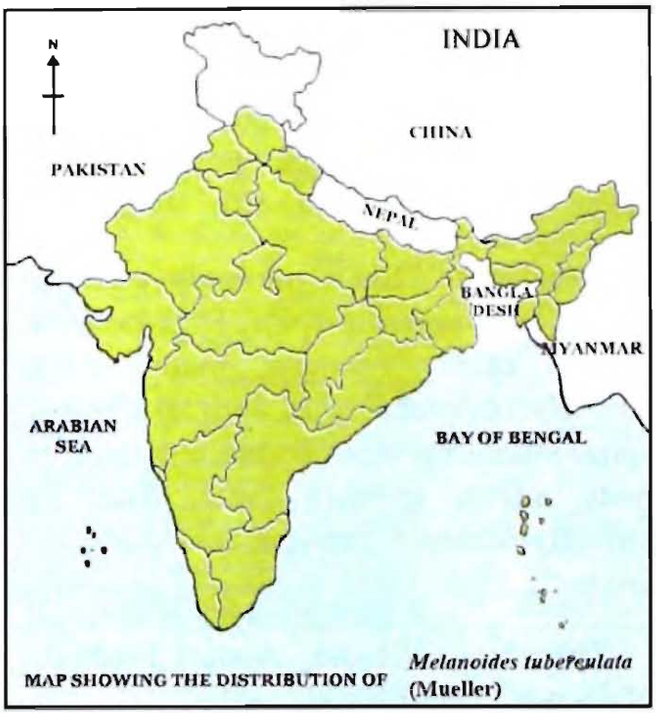
1989. *Thiara (Melanoides) tuberculata* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 103, figs. 183, 184.

Fig. 108. A. Dorsal view of *Melanoides tuberculata* (Mueller)

Fig. 108. B. Ventral view of *Melanoides tuberculata* (Mueller)

Type location : Not known.

Latest name and Reference : *Melanoides tuberculata* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 198. *Zool. Surv. India.*



MAP SHOWING THE DISTRIBUTION OF *Melanoides tuberculata* (Mueller)

Diagnosis : Shell with a high spire and moderately large body whorl; spire five times the height of the aperture; whorls 10-14, moderately convex, evenly rounded, dark red-brown dots and flames, either irregularly distributed or longitudinally arranged on the shell surface; sculptured conspicuosly with vertical ribs and spiral striae, distinct and raised on the upper whorls, but flatter on the lower ones; central teeth of radula usually with about 11 cusps.

Distribution : Widely distributed throughout India except Kashmir.

Elsewhere : North and South Africa (For details of its distribution from African Continent- See Brown, 1980, p. 94); Eastern Mediterranean countries; South East Asia; Southern China; Japan; Malaysia; Malay Archipelago; North Australia; various Pacific Islands and north to the Ryukyu Islands of Japan; New Hebrides.

Occurs in all possible water bodies of stagnant and slow moving freshwater ponds, tanks, canals, streams, ditches, drains, even in water mains and occupies as varied habitats as low saline water near sea level to freshwater at 1600 m altitude (Benthem Jutting, 1956). Dense population occurs on fine sediment in lakes, ponds and in small pools fed by perennial springs. Absent from the habitats that regularly dry out.

A number of cercariae were recorded from this snail. Sewell (1922) recorded *Cercaria indica* in addition to *C. aciculata, C. beschiensi, C. bhimtalensis, C. bristiae, C. bristpennata, C. claudiglandula, C. cordata, C. cruciata, C. dissimilis, C. fulvior, C. fulvaculata, C. goraliensis, C. nepprenocephalus, C. kukrailensis, C. naukuchiensis, C. pinjorensis* and avian parasites like *Paragonimus westermani, Stellantchasmus formosanum, Transversotrema patialensis* are recorded (Subba Rao, 1989).

Genus ***Stenomelania*** P. Fisher, 1885

1885. *Stenomelania*, P. Fischer, *Man. de Conchyl.*, **8**(8) : 701. Type species : *Melania aspirans* Hinds

Shell elongated, slender, whorls many, flat; spire attenuated and pointed; Sculpture smooth or with spiral threads or rows of beads, but not spines; Columella thin and without callus.

Mantle margin with 10-14 papillae. Ovoviviparous. Abbott (1948) reported absence of brood pouch in this genus, whereas Morrison (1954) reported the presence of brood pouch.

South East Asia, Malay Archipelago, Pacific Islands and Philippines.

Key to the species

1. Sculptured with strong spiral ridges, broken into rectangular nodules towards the suture ..... *S. torulosa* (Bruguiere)

– Sculptured without strong spiral ridges; apical whorl with some vertical ridges or folds ..... (2)

2. Shell broader, spire not attenuated ..... *S. punctata* (Lamarck)

– Shell very slender, spire attenuated ..... (3)

3. Upper whorls of the spire strongly folded; lower ones smoothor with spiral striae ..... *S. plicaria* (Born)

– Whorls of the spire not folded, shell with fine spiral lines throughout .... *S. aspirans* (Hinds)

Stenomelania aspirans (Hinds, 1874)

1874. *Melania aspirans* Hinds, *Ann. Mag. Nat. Hist.* 1874 : 8. Type locality : Fiji.

1908. *Melania charon* Preston, *Rec. Indian Mus.*, **2** : 196, pl.15, figs. 22. Type locality : Andaman Islands.

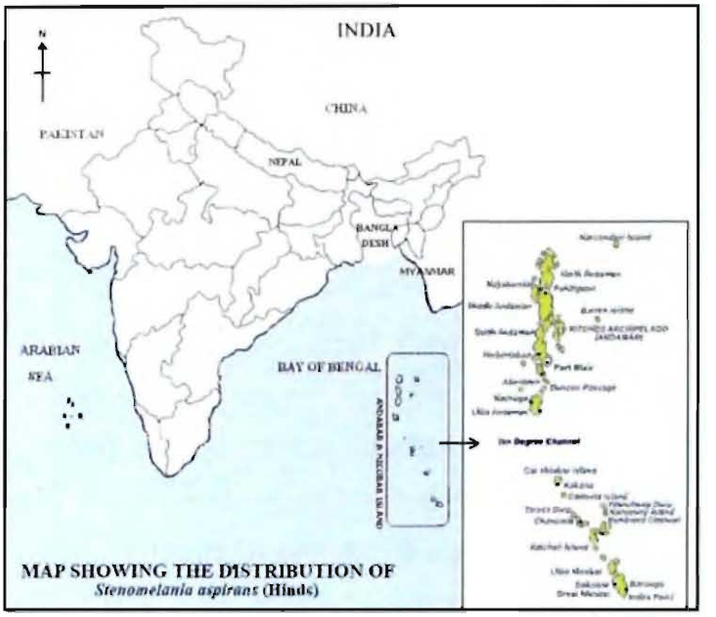
1976. *Melanoides (Stenomelania) aspirans* : Starmuehlner, *Ann. Naturhist. Mus. Wien.* **80** : 577, figs. 180 a-b, pl. 17, figs. 195, 196.

Fig. 109. A. Dorsal view of *Stenomelania aspirans* (Hinds)

Fig. 109. B. Ventral view of *Stenomelania aspirans* (Hinds)

Type location : Not known.

Latest name and Reference : *Thiara (Stenomelania) aspirans* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 99, fig. 206.



Diagnosis : Shell high, turreted, extremely attenuate, with more than 12 whorls; sculpture with spiral ridges on the upper and basal part of the whorls leaving the central part smooth, suture margined by a somewhat stronger ridge. Whorls mostly eroded, regularly increasing in size, aperture nearly vertical, pointed above, rounded or almost straight below.

Distribution : India : Andaman and Nicobar Islands.

Elsewhere : Bismarck Archipelago, Fiji, New Hebrides, New Caledonia, Samoa and Solomon Islands.

Stenomelania plicaria (Born, 1780)

1780. *Helix plicaria* Born, *Test. Mus. Caes, Vindob,* : 389, pl. 16. fig. 14. Type liocality : ?

1973. *Thiara (Stenomelania) plicaria* : Pace, *Mal. Review Supplement,* **1** : 65, pl.12, fig. 9, pl.13, fig. 6.

1976. *Melanoides (Stenomelania) plicaria* : Starmuehlner, *Ann. Naturhist. Mus. Wien.*, **80** : 580, figs. 87-97, pl. 16, figs. 182-194.

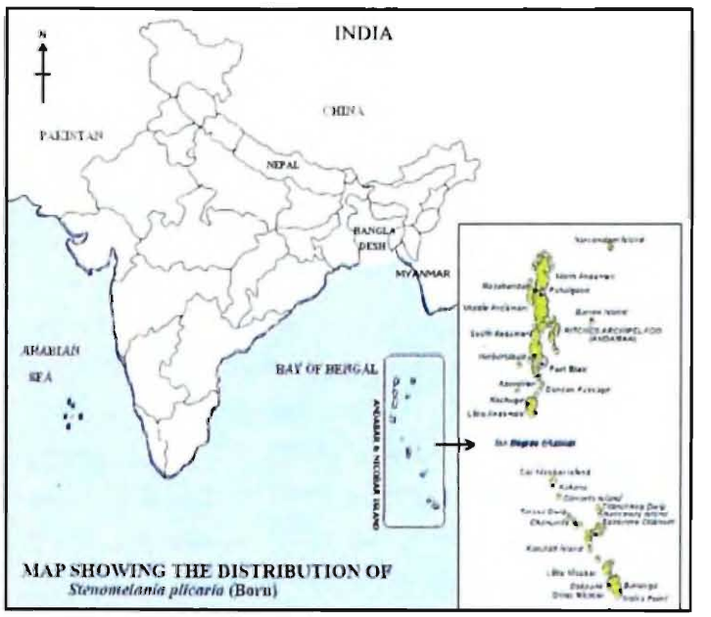
Fig. 110. A. Dorsal view of *Stenomelania plicaria* (Born)

Fig. 110. B. Ventral view of *Stenomelania plicaria* (Born)

Type location : Not known.

Latest name and Reference : *Thiara (Stenomelania) plicaria* : Subba Rao 1989, *Handbook of Freshwater Molluscs of India*, p. 99.

Diagnosis : Shell long and slender whorls numerous, flat, tapering to a fine and acute apex, spiral whorls a little convex, spiral sculpture strongest on the base and near the sutures, the initial whorls with strong vertical plicae. Aperture vertical, outerlip slightly sinuous and protruding in the middle.



Distribution : India : Andaman and Nicobar Islands.

Elsewhere : Malagasy, Malay Archipelago, Philippines to Fiji Islands and on the north extending upto Ryukyu Islands, Japan.

Stenomelania punctata (Lamarck, 1822)

1822. *Melania punctata* Lamarck, *Hist. Nat. Anim. Sans. Vert.*, **6**(2) : 165. Type locality : ?

1915. *Thiara (Radina) clavus* : Preston, *Fauna. Brit. India.* Mollusca (Freshwater Gastropoda and Pelecypoda), p.12.

1976. *Malanoides (Stenomelania) punctata* : Starmuehlner, *Ann. Naturhist. Mus. Wien.*, **80** : 586, figs., 98-108, pl. 17, figs. 197-201.

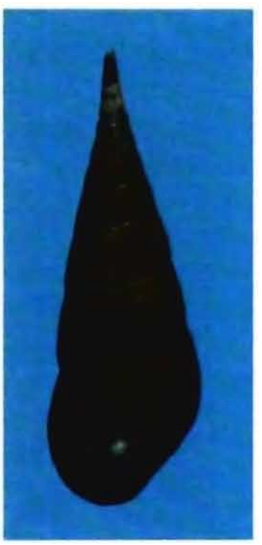
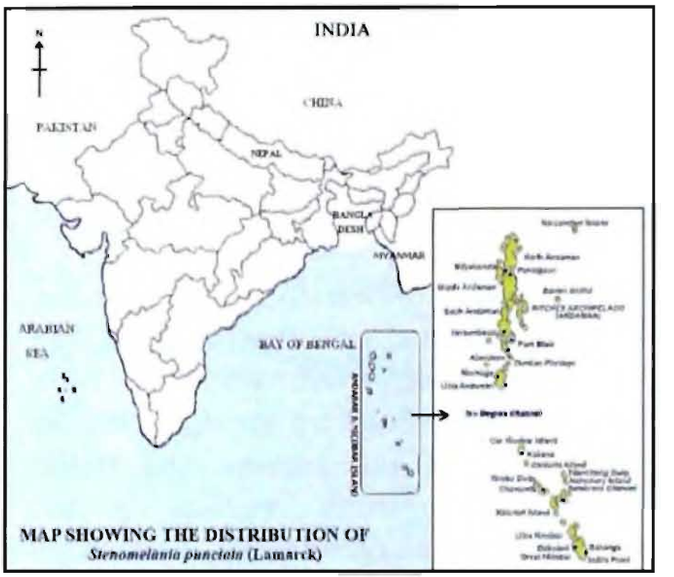


Fig. 111. A. Dorsal view of *Stenomelania punctata* (Lamarck)

Fig. 111. B. Ventral view of *Stenomelania punctata* (Lamarck)

Type location : Museum D'Histoire Naturelle, Geneva.

Latest name and Reference : *Thiara (Stenomelania) punctata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 98, figs. 210-211.



Diagnosis : Shell turret-elongated, body whorl broad, spire not much attenuate, smooth, whorls flat, 14-16, regularly increasing in size, sutures not deep, aperture pointed above and rounded below, operculum horny, pear to oval shaped with excentric nucleus situated at the lower left corner.

Distribution : India : Andaman and Nicabar Islands.

Elsewhere : Malay Archipelago, Indonesia, Java, Moluccas, New Guinea, Bismarck Archipelago, Solomon Islands, New Hebrides, Philippines, Caroline Island, New Caledona, Australia, Dutch East Indies.

Stenomelania torulosa (Bruguiere, 1789)

1789. *Bulimus torulosus* Bruguiere, *Encycl. Meth. Vers.*, **1** : 332. Type locality : ?

1915. *Tiara (Radina) crenulata* : Preston, *Fauna Brit. India*, Mollusca (Freshwater Gastropoda and Pelecypoda), p.11.

1973. *Thiara (Stenomelania) torulosa*, : Pace, *Mal. Review. Supplement.*, **1** : 66.

1989. *Thiara (Stenomelania) torulosa* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 100, fig. 202.

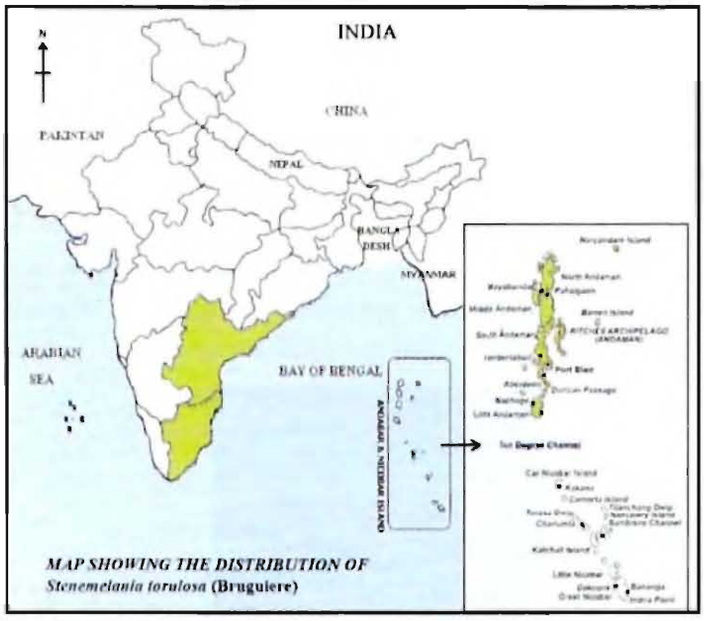
Fig. 112. A. Dorsal view of *Stenomelania torulosa* (Bruguiere)

Fig. 112. B. Ventral view of *Stenomelania torulosa* (Bruguiere)

Type location : Not known.

Latest name and Reference : *Stenomelania torulosa* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 199. *Zool. Surv. India.*

Diagnosis : Shell elongate turreted, whorls 12-14, thick with strong spiral sculpture broken up by transverse lines into rectangular nodules, aperture pyriform, pointed above and rounded below, columellar side somewhat twisted and curved to the right, outer lip crenulated.



Distribution : India : Andamans, Andhra Pradesh : Prakasam, Visakhapatnam; Tamil Nadu : Porto Novo.

Elsewhere : Malagasy, SouthEast Asia, Malaysia, Philippines, Taiwan and Solomon Islands.

Genus ***Tarebia*** H. and A. Adams, 1854

1854. *Tarebia* H. and A. Adams, *Gen. Rec. Moll.*, **1** : 304.Type species: *Tarebia semigranosa* von dem Busch, 1842 subsequent designations by Morrison, 1952.

Shell medium, ovately fusiform; whorls granulose or tessellated with nodules; outer lip situated below; interior of aperture with spiral grooves.

Key to the species

1. Height of body whorl more than half of the total length of shell; dark spiral lines on body whorl absent or very indistinct ..... (2)

– Height of body whorl half or less than the total length of shell; presence of distinct, dark, spiral line on the body whorl present ..... *T. lineata* Gray

2. Shells comparatively small, spire very sharp, sculptured with distinct spiral rows of nodules ..... *T. granifera* (Lamarck)

– Shell comparatively large, spire not very sharp, sculptured with distinct rows of granules ..... *T. semigranosa* von dem Busch

Tarebia granifera (Lamarck, 1822)

1822. *Melania granifera* Lamarck, *Hist.nat. Anim. Sans. Vert.*, **6**(2) : 167. Type locality : ?

1973. *Thiara (Tarebia) granifera* : Pace, *Mal. Review. Supplement*, **1** : 62, pl. 12, fig. 3, pl. 13, fig. 4.

1976. *Tarebia granifera* : Starmuehlner, *Ann. Natur. Hist. Mus. Wien.*, **80** : 569. figs. 72-75, pl. 16, figs. 175-179.

1989. *Thiara (Tarebia) granifera* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 101, figs. 212, 213.

Fig. 113. A. Dorsal view of *Tarebia granifera* (Lamarck)

Fig. 113. B. Ventral view of *Tarebia granifera* (Lamarck)

Type location : Not known.

Latest name and Reference : *Tarebia granifera* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 199. *Zool. Surv. India*:

Diagnosis : Shell elongately conical; sculptured with distinct spiral rows of nodules, spire sharp with flat whorls, height of body whorl more than half of the shell.

Distribution : India : Andaman and Nicobar Islands; Andhra Pradesh : Prakasam, Srikakulum; Bihar, Jharkhand; Madhya Pradesh, Maharashtra; Manipur :

MAP SHOWING THE DISTRIBUTION OF *Tarebia granifera* (Lamarck)

Imphal; Meghalaya : Garo hills (West), Khasi hills (East); Mizoram; Tripura (West and East); West Bengal : Birbhum, Kolkata, Hugli, Nadia, Puruliya, North 24 Paraganas.

Elsewhere : Formosa, Malagasy, Malaysia, Myanmar, Pacific Islands, Philippines, Taiwan. Introduced into U.S.A (Abbott, 1952).

Tarebia lineata (Gray, 1828)

1828. *Helix lineata* Gray, in *Wood's Index Test. Suppl.*, : 24, fig. 68. Type locality : Ganges.

1915. *Tiara (Tarebia) lineata* : Preston, *Fauna Brit. India*, Mollusca (Freshwater Gastropoda and Pelecypoda) : 34.

Fig. 114. A. Dorsal view of *Tarebia lineata* (Gray)

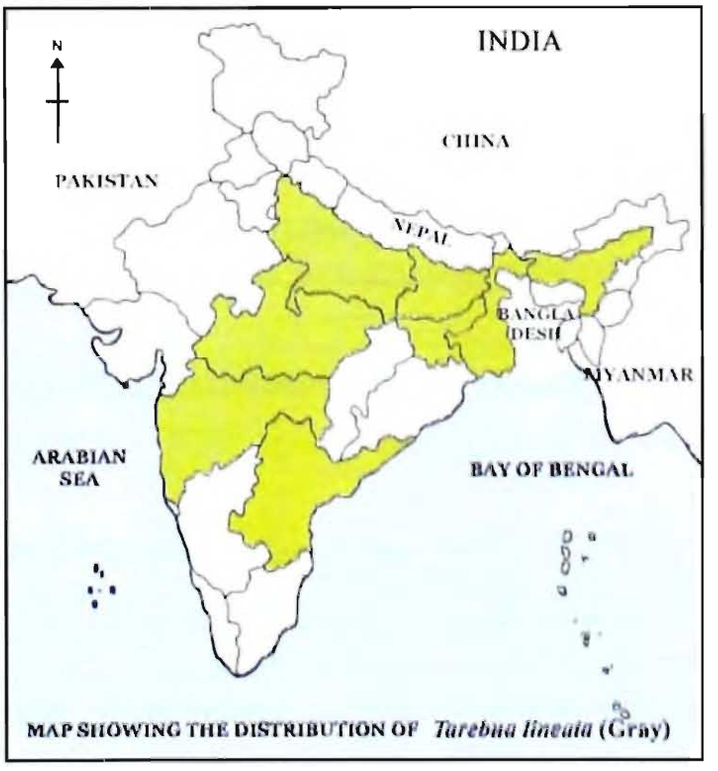
Fig. 114. B. Ventral view of *Tarebia lineata* (Gray)

Type location : National History Museum, London.

Latest name and Reference : *Tarebia lineata* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 200. *Zool. Surv. India*:

Diagnosis : Shell elongate, conical, rows of nodules less distinct, rather obsolete on the lower whorls, dark spiral lines distinct, apex acute.

Bioecological studies of this species, including brood pouch count, population, growth rate etc. were made by Subba Rao and Mitra (1982).



MAP SHOWING THE DISTRIBUTION OF *Tarebia lineata* (Gray)

Distribution : India : Andhra Pradesh : Cuddapah, Khammam, Kurnool, Prakasam, Srikakulum, Assam, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Uttar Pradesh, West Bengal : Bardhaman, Kolkata, Haora, Hugli, Nadia, North & South 24 Paraganas.

Elsewhere : Bhutan, Myanmar, Sri Lanka.

Tarebia semigranosa (von dem Busch, 1842)

1842. *Melania semigranosa* von dem Busch, in Philippi's, *Abbild. Buschr. Conchyl.*, **1** : 2, pl. 1, figs. 13a & b. Type locality : Java.

Fig. 115. A. Dorsal view of *Tarebia semigranosa* (von dem Busch)

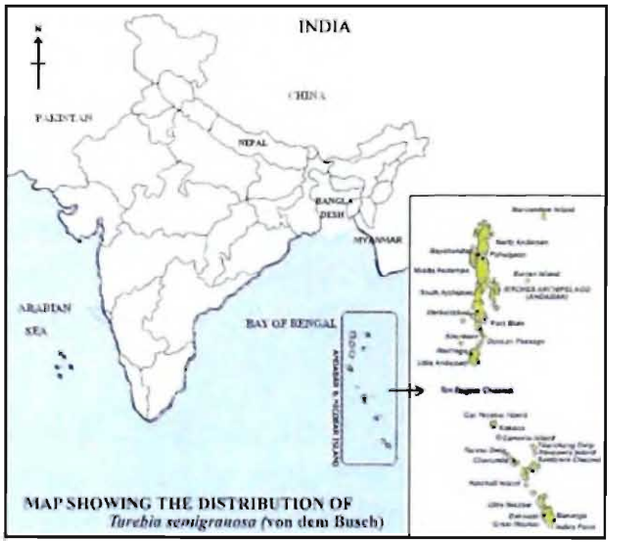
Fig. 115. B. Ventral view of *Tarebia semigranosa* (von dem Busch)

Type location : Not known.

Latest name and Reference : *Tarebia semigranosa* : Subba Rao, *Das and Mitra*, 1980, *Rec. zool. Surv. India*, **77**, p. 237.

Diagnosis : Shell ovately fusiform; sculptured with tessellated nodules; spire sharp with flat whorls; interior of aperture with spiral grooves.

Distribution : India : Andaman and Nicobar Islands.



Family PLEUROCERIDAE

Shell rounded, oval or tower shaped. Sculpture variable, smooth or spirally, striated, ribbed or tuberculated; periostracum strong; columellar margin thick, more or less arched. Aperture ovate, proportionately large, angular notched or obliquely grooved

below; operculum paucispiral, spiral with upto six whorls, nucleus approximately central.

Radula remarkably long with rectangular central tooth. Mantle not fringed. Sexes separate, oviparous or viviparous. Female with a genital groove on the right side but lacking genital pit.

Found in freshwater of West Africa, Malagasy, South and South-east Asia.

Vaught (1989) divided this family into six subfamilies, out of which two subfamilies represented from India.

Subfamily MELANATRIINAE

Shell tower shaped, smooth or with variable sculpture; sculpture smooth or spirally striate, ribbed or tuberculate; columellar margin thick, more or less arched, aperture with angular below; operculum spiral with six whorls nucleus approximately central.

Radula remarkably long with an approximately rectangular central tooth. Mantle not fringed, smooth, with a small, fleshy, cup shaped fold on the right side opposite to the anal opening. A genital groove on the right side; genital pit absent.

Freshwater. West Africa, Malagasy and South-east Asia.

Represented by two genera *Brotia* H. Adams and *Sulcospira* Troschel from India.

This subfamily was hitherto treated under family Thairidae. Following Vaught (1989) it is now kept under the family Pleuroceridae along with Paludominae.

Key to the genera

1. Shell ovoid, conical, spire equal or less than body whorl; aperture oval, somewhat expanded at the base ..... ***Sulcospira*** Troschel

– Shell high conoid or turreted, spire longer than the body whorl; aperture more or less rounded ..... ***Brotia*** H. Adams

Genus ***Brotia*** H. Adams, 1866

1866. *Brotia* H. Adams, *Proc. Zool. Soc. Lond.*, **1866** : 150. Type species : *Melania pagodula* Gould, 1947 by Monotype.

Shell high conoid or turreted with many whorls; spire longer than body whorl; apex asymmetrical, covered with dark brown or black epidermis; axial ribs heavy; columellar angle of tip of aperture produced slightly forward or round; operculum, multispiral, round with central nucleus.

Snout broad and protrusible. Tentacles long and slender. Foot short and slender. Mainly parthenogenetic. Davis (1971) recorded the male which are rare; brood pouch similar with that in *Thiara*.

India, Indo-china, Malay Archipelago, Malaysia and Philippines.

Subgenus ***Antimelania*** Fischer and Crosse, 1892

1892. *Antimelania* Fischer and Crosse, *Miss. Mex.*, **7**(2) : 313. Type species : *Melania variabilis* Benson, 1836= *Melania costula* Rafinesque, 1833.

Aperture more or less regularly rounded at base, but not projecting as in the case of *Brotia* s. st.

Brotia (Antimelania) costula (Rafinesque, 1833)

1833. *Melania costula* Rafinesque, *Atlantic J.*, **5** : 166. Type locality : Gomti river, at Jaunpur, Uttar Pradesh.

1956. *Brotia costula* : van Benthem Jutting, *Treubia*, **23**(2) : 374, fig. 76.

1989. *Brotia (Antimelania) costula* : Subba Rao, *Handbook of Freshwater Molluscs of India* : 108, figs. 192-194, 197, 198.

Fig. 117. A. Dorsal view of *Brotia (Antimelania) costula* (Rafinesque)

Fig. 117. B. Ventral view of *Brotia (Antimelania) costula* (Rafinesque)

Fig. 118. A. External view of *Brotia (Antimelania) costula* (Rafinesque)

Fig. 118. B. Internal view of *Brotia (Antimelania) costula* (Rafinesque)

Fig. 119. A. External view of *Brotia (Antimelania) costula* (Rafinesque)

Fig. 119. B. Internal view of *Brotia (Antimelania) costula* (Rafinesque)

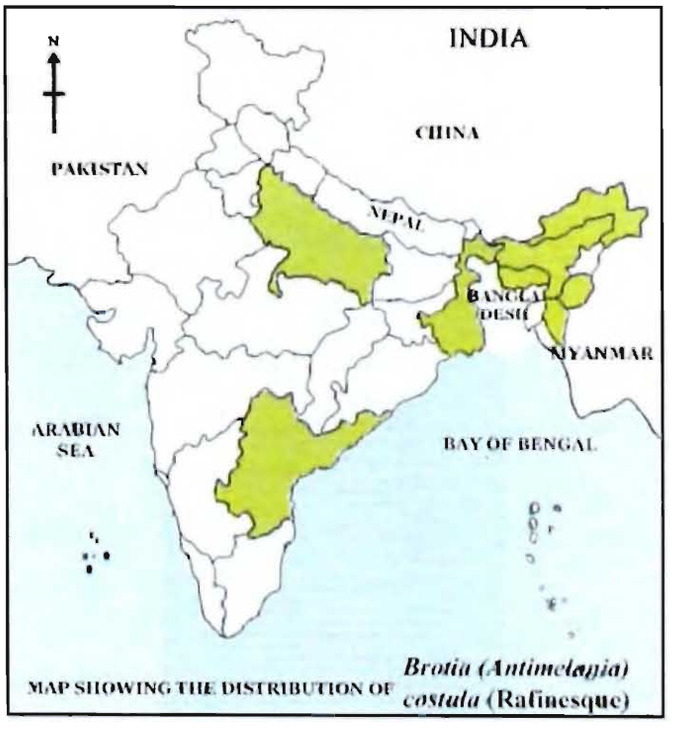
Fig. 120. A. External view of *Brotia (Antimelania) costula* (Rafinesque)

Fig. 120. B. Internal view of *Brotia (Antimelania) costula* (Rafinesque)

Type location : Not known.

Latest name and Reference : *Brotia (Antimelania) costula* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series,* **10**, p. 78, pl. 2, fig. 5. *Zool. Surv. India,*

Diagnosis : Shell elongate, whorls 12-14, regularly increasing, sculpture with spiral ridges or nodules, prominent axial ribs, often with spines.



MAP SHOWING THE DISTRIBUTION OF *Brotia (Antimelania) costula* (Rafinesque)

It is very much variable in shape and as result a number of varities were described by different authors. Annandale (1921) described three varities namely *laevis* Annandale, *semilaevigata* Nevill and *subspinata* Annandale from Manipur. Other varities are *echinata* (Benson), *intermedia* (Brot), *subspinosa* (Nevill) and *subtuberculata* (Nevill).

Found in muuddy waters and muddy bottoms of rivers and stagnant water.

Distribution : India : Andhra Pradesh, Arunachal Pradesh, Assam : Kaziranga, Sibsagar; Manipur : Chandel, Imphal, Thoubal; Meghalaya : Garo hills (East and West), Khasi hills (West), Jantia hills, Ri-Bhoi; Mizoram, Tripura, Uttar Pradesh, West Bengal : Kolkata, Hugli, North and South 24-Paraganas.

Elsewhere : Bhutan, Indonesia, Malaya Archipelago, Myanmar, Pakistan, Sumatra, Thailand.

Genus ***Sulcospira*** Troschel, 1858

1858. *Sulcospira* Troschel, *Gebiss Schnecken,* **1** : 117. Type species : *Melania huegeli* Philippi.

Shell conical, ovoid, not much slender, spirally grooved, especially the basal region of whorls luster less; aperture oval, expanded at base, siphonal canal absent; operculum multispiral with central nucleus. Females ovoviviparous.

India and Indonesia.

Sulcospira huegeli (Philippi, 1841)

1841. *Melania huegeli* Philippi, *Abbild. Beschreib. Conch.*, **1** : 61, pl. 2, fig. 8. Type locality : New Holland?

1953. *Melania blisteri* : Ray, *Rec. Indian Mus.*, **50**(1) : 112, pl. 1, figs. 1-6, 1a-6a. Type locality : Coromandel Coast.

Type location : Not known.

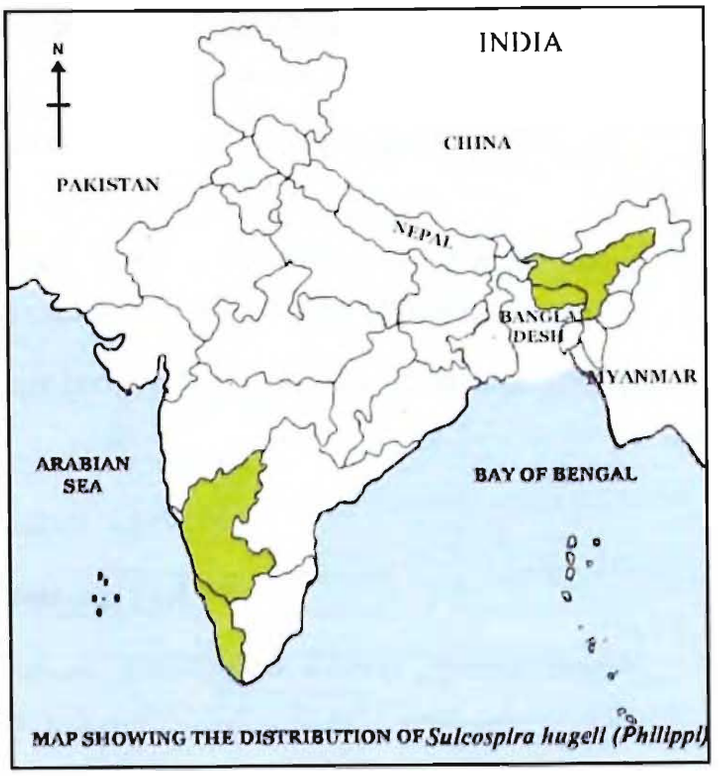
Fig. 121. A. Dorsal view of *Sulcospira huegeli* (Philippi)

Fig. 121. B. Ventral view of *Sulcospira huegeli* (Philippi)

Latest name and Reference : *Sulcospira huegeli* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 107, fig. 200.

Diagnosis : Shell ovoid conical; spire generally decollated; whorls 5-6, regularly increasing in size, body whorl large, almost equal to the height of the spire; sculpture nearly smooth, with spiral striae below the periphery of the body whorl; aperture vertical and produced at the base, dark brown.

Remarks : *Melania blisteri* Ray having the blisters which might be because of ecological conditions.



MAP SHOWING THE DISTRIBUTION OF *Sulcospira hugeli (Philippi)*

Distribution : Assam, Karnataka : Upper Cauvery River, Bangalore; Kerala : Wynaad, Cochin Hills; Meghalaya : Khasi and Garo Hills.

Subfamily PALUDOMINAE

Shell oval or rounded, with strong periostracum; sculpture smooth or with spiral markings; aperture large, ovate, notched or obliquely grooved below; operculum round with concentric ridges.

Mantle margin with 20 to 25 equal, small protrubances or papillae. Oviparous. An egg laying groove present on right side of foot.

India, Myanmar, Sri Lanka, Sumatra.

Genus ***Paludomus*** Swainson, 1840

1840. *Paludomus* Swainson, *Treatise on Malacology*, **1840** : 340. Type species : *Melania globulosa* Gray

Shell thick, heavy, oblong-globose; aperture larger than spire, columella very thick.

India : North east and South west; Myanmar, Sri Lanka.

Key to the subgenera

1. Spire depressed, columella broad and flat ..... (2)

– Spire elevated, columella narrow, not very flat ..... (3)

2. Columella without tooth or projection, operculum with lateral and dextral nucleus ..... ***Tanalia*** Gray

– Columella with prominent tooth like projection, operculum with excentric nucleus ..... ***Stomatodon*** Benson

3. Operculum with submedian nucleus displaced to the left, growth striae subspiral and stair-step like growth lines ..... ***Paludomus*** s. str.

– Operculum with subbasal and dextral nucleus, growth striae paucispiral ..... ***Philopotamis*** Layard

Subgenus ***Paludomus*** s. st.

Key to the species

1. Whorls conspicuously shouldered, crown with short and pointed spines ..... *P. (P.) stephanus* (Benson)

– Whorls not conspicuously shouldered, nor crowned with short and pointed spines ..... (2)

2. Sculpture with reticulate spiral striations, form axial granulations ..... *P. (P.) reticulata* Blanford

– Sculpture without reticulate spiral striations, no axial granulations ..... (3)

3. Spire acuminate or highly pointed ..... (4)

– Spire depressed ..... (5)

4. Sculptured with broad spiral ridges throughout the body whorl ..... *P. (P.) regulata* Benson

– Sculptured with fine spiral ridges, present only on the lower portion of the body whorl and 2-3 on sutural region ..... *P. (P.) ornatus* Benson

5. Sculptured with very fine spiral striae, almost smooth or with coarser longitudinal lines ..... (6)

– Sculptured with fine spiral striae throughout or on part of the body whorl..... (10)

6. Whorls more than five ..... (7)

– Whorls five or less ..... (8)

7. Body whorl more globose, first few whorls with keeled spiral ridges, body with dark brown spots running with lines ..... *P. (.P) transchauricus* (Gmelin)

– Body whorl elongated ovate, whorls not keeled, body without dark brown spots running in lines ..... *P. (P.) obesus* (Philippi)

8. Shell with distinct chocolate brown broad bands .....(9)

– Shell without distinct chocolate brown broad bands..... *P. (P.) rotunda* Blanford

9. Shell ovate, with coarses longitudinal lines ..... *P. (P.) pustulosa* Annandale

– Shell ovately globose, without coarses longitudinal lines .... *P. (P.) blanfordiana* Nevill

10. Shell with dark spiral bands .....*P. (P.) conica* (Gray)

– Shell without spiral bands .....(11)

11. Spiral ridges present only on sutural region .....*P. (P.) annandalei* Preston

– Spiral ridges present on sutural and mid region of body whorl*P. (P.) inflatus* Brot

Paludomus (Paludomus) annandalei Preston, 1909

1909. *Paludomus annandalei* Preston, *Rec. Indian Mus.*, **3** : 278, fig. 1. Type locality : Tenmalai, Western Ghats (West).

Type location : National Zoological Collection, ZSI, Regd. No. M 4610/1 (Holotype), M 17433/3 (Paratypes).

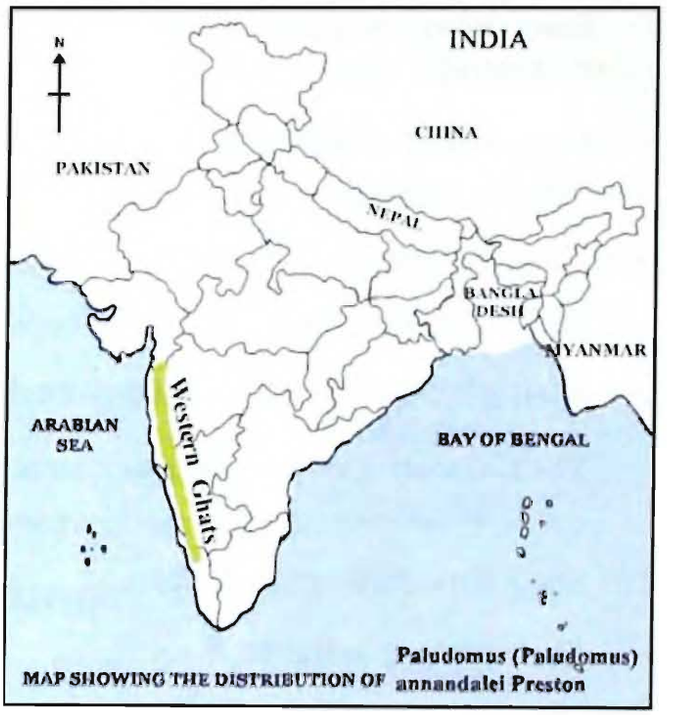
Fig. 122. A. Dorsal view of *Paludomus (Paludomus) annandalei* Preston

Fig. 122. B. Ventral view of *Paludomus (Paludomus) annandalei* Preston

Latest name and Reference : *Paludomus (Paludomus) annandalei* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 112, fig. 218.

Diagnosis : Shell conoidal, apex eroded; sutures slightly impressed, sculptured with coarse spiral striae below the sutures and on the basal part of the whorls, interstices with punctate appearance, columella arched, hardened into a nodule at the point of meeting the outer lip; dark olivaceous brown.

Distribution : India : Western Ghats.



Paludomus (Paludomus) blanfordiana Nevill, 1877

1877. *Paludomus blanfordiana* Nevill, *J. Asiat. Soc. Beng.*, **46**(2) : 37. 1881. Nevill, *J. Asiat. Soc. Beng.*, **50**(2) : 159, pl.5, figs. 3, 3a. Type locality : Ava, Burma.

1915. *Paludomus rotungensis* : Preston, *Rec. Indian Mus.*, **8** : 539, figs. 3, 3a. Type locality : Upper Rotung.

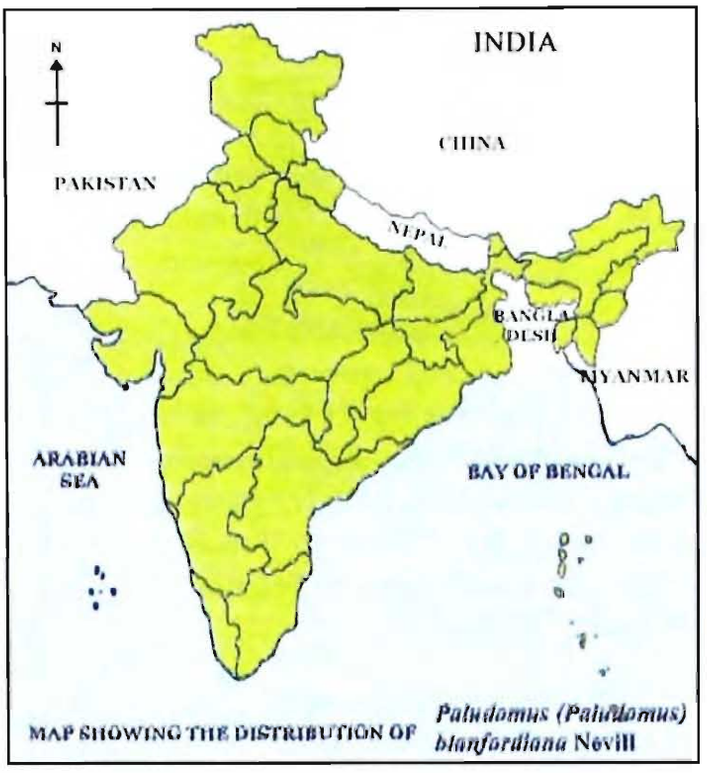
1989. *Paludomus (Paludomus) blanfordiana* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 112, figs. 222, 239.

Type location : National Zoological Collection, ZSI, M 18896/3 (Syntypes).

Fig. 123. A. Dorsal view of *Paludomus (Paludomus) blanfordiana* Nevill

Fig. 123. B. Ventral view of *Paludomus (Paludomus) blanfordiana* Nevill

Latest name and Reference : *Paludomus (Paludomus) blanfordiana* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 78. *Zool. Surv. India.*



Diagnosis : Shell ovately globose, body whorl inflated, colour dark yellow, often coated with black encrustation, almost smooth, body whorl with three characteristics chocolate brown broad bands, which very distinct by visible through the aperture, aperture oval, margin of columellar callus tinged with chocolate brown colour.

Distribution : India : Assam : Guahati; Meghalaya : Siju cave, Garo Hills, Ri-Bhoi; Mizoram, Tripura (West), Manipur : Imphal, Chandel, Churachandpur, Thoubal.

Elsewhere : Myanmar : Pegu, Arakan.

Paludomus (Paludomus) conica (Gray, 1834)

1834. *Melania conica* Gray, *Griffith Cuvier, Moll.*, : pl. 14, fig. 5.

1989. *Paludomus (Paludomus) conica* : Subba Rao, *Handbook of Freshwater Molluscs of India* : 113, figs. 227, 228.

Fig. 124. A. Dorsal view of *Paludomus (Paludomus) conica* (Gray)

Fig. 124. B. Ventral view of *Paludomus (Paludomus) conica* (Gray)

Type location : Not known.

Latest name and Reference : *Paludomus (Paludomus) conica* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 79. *Zool. Surv. India.*

Diagnosis : Shell globose conical, whorls 5, smooth for the most part excepting for one broad or three to four spiral ridges in the sutural region, and few on mid region of body whorl. Colour yellowish brown to dark brown, often ornamented with dark spiral bands as in *P. blanfordiana*.

MAP SHOWING THE DISTRIBUTION OF *Paludomus (P.) conica* (Gray)

Distribution : India : Meghalaya : Teria Ghat, South Jaintia Hills, Garo Hills, Kopili river, West Khasi Hills, Ri-Bhoi; Tripura (West, South and North).

Elsewhere : Bangladesh, Bhutan.

Paludomus (Paludomus) conica var. ***kopiliensis*** Nevill

1884. *Paludomus (Paludomus) conica* var. *kopiliensis* Nevill, *Hand List Moll. Indian Mus.*, **2** : 289.

Type location : National Zoological Collection, ZSI; Reg. No. M 21554/4 (Holotype).

Fig. 125. A. Dorsal view of *Paludomus (Paludomus) conica* var. *kopiliensis* Nevill

Fig. 125. B. Ventral view of *Paludomus (Paludomus) conica* var. *kopiliensis* Nevill

Fig. 126. A. External view of *Paludomus (Paludomus) conica* var. *kopiliensis* Nevill

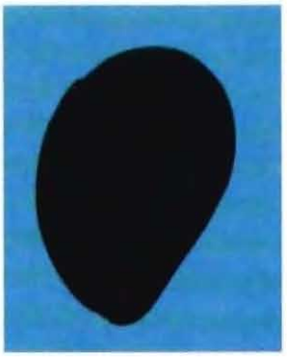


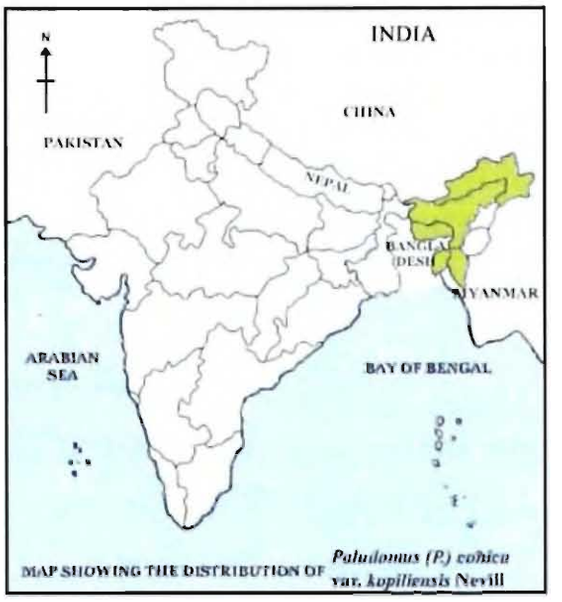
Fig. 126. B. Internal view of *Paludomus (Paludomus) conica* var. *kopiliensis* Nevill

Latest name and Reference : *Paludomus conica* var. *kopiliensis* : Mookherjee, Thakur, Mitra and Barua, 2000. *Fauna of Tripura, State Fauna Series*, **7**, p. 331, *Zool. Surv. India.*

Diagnosis : Shell in this subspecies differs from the typical form in having, a shorter spire, a proportionately larger and much inflated body whorl, which is subangulate at the periphery. Body whorl with fine spiral ridges below the suture.

Distribution : India : Assam, Arunachal Pradesh, Meghalaya, Mizoram, Tripura (South).

Elsewhere : Bhutan, Bangladesh.



Paludomus (Paludomus) inflatus Brot, 1880

1880. *Paludomus inflatus* Brot, in *Martini Chemnitz, Syst. Conch. Cab.*, **1**(25) : 44, pl. 18, figs. 25, 26. Type locality :?

1974. *Paludomus (Paludomus) inflatus* : Starmuehlner, *Bull. Fish. Res. Stn., Sri Lanka*, **25**(1) : 139, pl. 8, fig. 78.

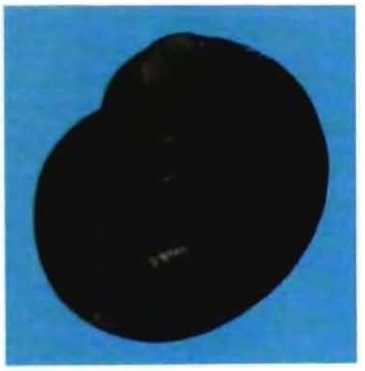


Fig. 127. A. Dorsal view of *Paludomus (Paludomus) inflatus* Brot

Fig. 127. B. Ventral view of *Paludomus (Paludomus) inflatus* Brot

Latest name and Reference : *Paludomus (Paludomus) inflatus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 114, figs. 244, 245.

Diagnosis : Shell globose, spire elevated, apex mostly decollated, body whorl abruptly enlarged and globular, flat below the suture and then arched; sculpture with distinct unequal spiral furrows; aperture broad and ovate.

Distribution : India : Kerala : Western Ghats, Amerghat; Tamil Nadu : Tinnevalley.

Elsewhere : Rare in Eastern Sri Lanka.

MAP SHOWING THE DISTRIBUTION OF *Paludomus (P.) inflatus* Brot

Paludomus (Paludomus) obesus (Philippi, 1842)

1842. *Melania obesa* Philippi, *Abbild. Beschreib. Conch.*, **2** : 170, *Melania*, pl. 4, fig. 3. Type locality : Patria ? Nova Hollandia.

Type location : Not known.

Fig. 128. A. Dorsal view of *Paludomus (Paludomus) obesus* (Philippi)

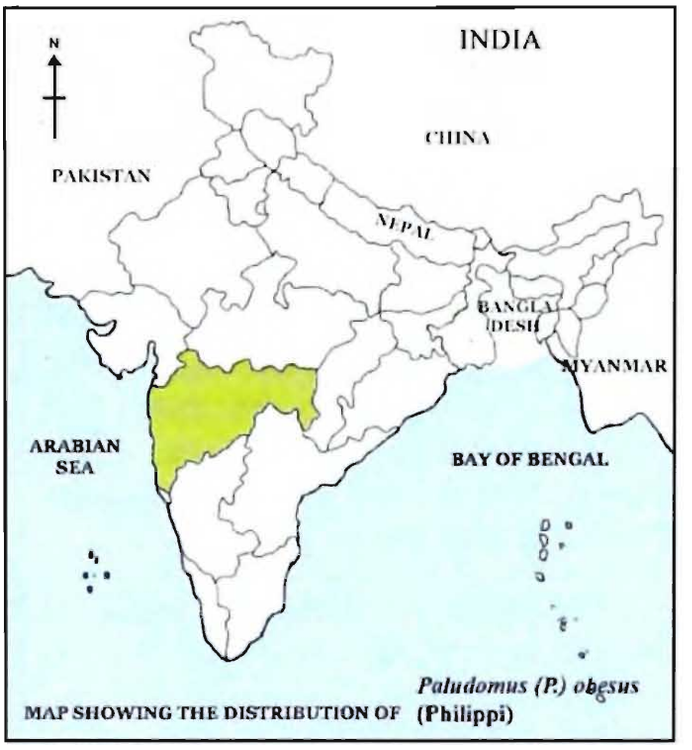
Fig. 128. B. Ventral view of *Paludomus (Paludomus) obesus* (Philippi)

Latest name and Reference : *Paludomus (Paludomus) obesus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 115, fig. 232.

Diagnosis : Shell globose, elongated and eroded spire; whorls depressed around the upper part; bodywhorl more than 2/3rd of the length; yellowish brown to olive; columellar callus thick and expanded.

Distribution : India : Maharashtra : Mumbai, Khandala, Ahmednagar and Ratnagiri.

Remarks : Though Annandale (1919) refered to this as a widely distributed species, from the studies it is evident that this species is restricted to the Western India only.



MAP SHOWING THE DISTRIBUTION OF

Paludomus (Paludomus) ornatus Benson, 1856

1856. *Paludomus ornata* Benson, *Ann. Mag. Nat. Hist.*, (2)**17** : 496. Type locality : Upper Myanmar.

Type location : Not known.

Fig. 129. A. Dorsal view of *Paludomus (Paludomus) ornatus* Benson

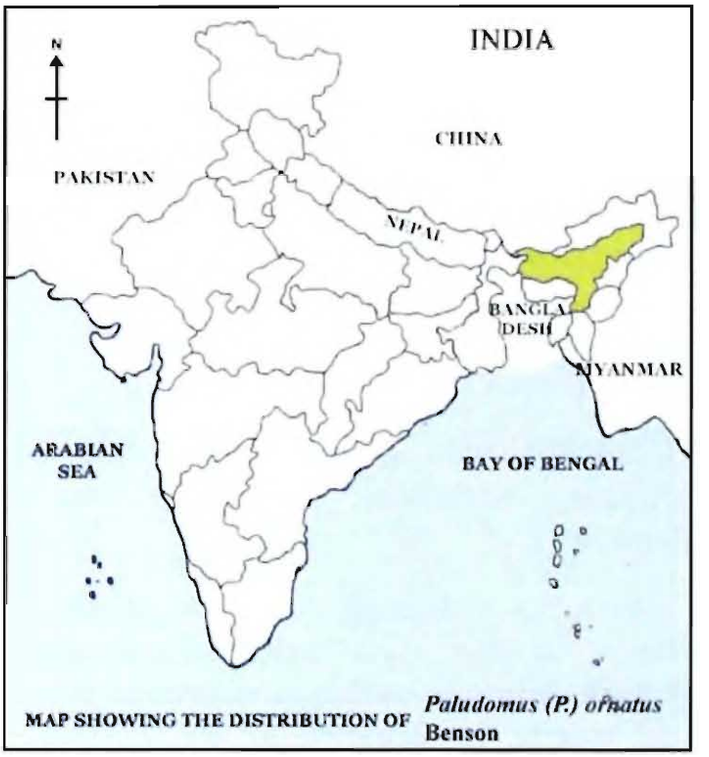
Fig. 129. B. Ventral view of *Paludomus (Paludomus) ornatus* Benson

Latest name and Reference : *Paludomus (Paludomus) ornatus* : Subba Rao, 1989, Handbook *of Freshwater Molluscs of India*, p. 115, fig. 220.

Diagnosis : Shell ovately conical; spire acuminate; whorls 6, sculpture smooth except for 2 or 3 spiral ridges in the sutural region; below the suture flat; aperture ovate, inside with three dark bands, columella arched and thick, straight below, outerlip sharp, angular above and then almost straight.

Distribution : India : Assam : Brahmaputra valley.

Elsewhere : Myanmar.



MAP SHOWING THE DISTRIBUTION OF *Paludomus (P.) ornatus* Benson

Paludomus (Paludomus) pustulosa Annandale, 1925

1921. *Paludomus pustulosa* Annandale, *Rec. Indian Mus.*, **22** : 563, figs. 11A, B. Type locality : Stream in the south part of the Manipur Valley.

1989. *Paludomus (Paludomus) pustulosa* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 116, fig. 234.

Fig. 130. A. Dorsal view of *Paludomus (Paludomus) pustulosa* Annandale

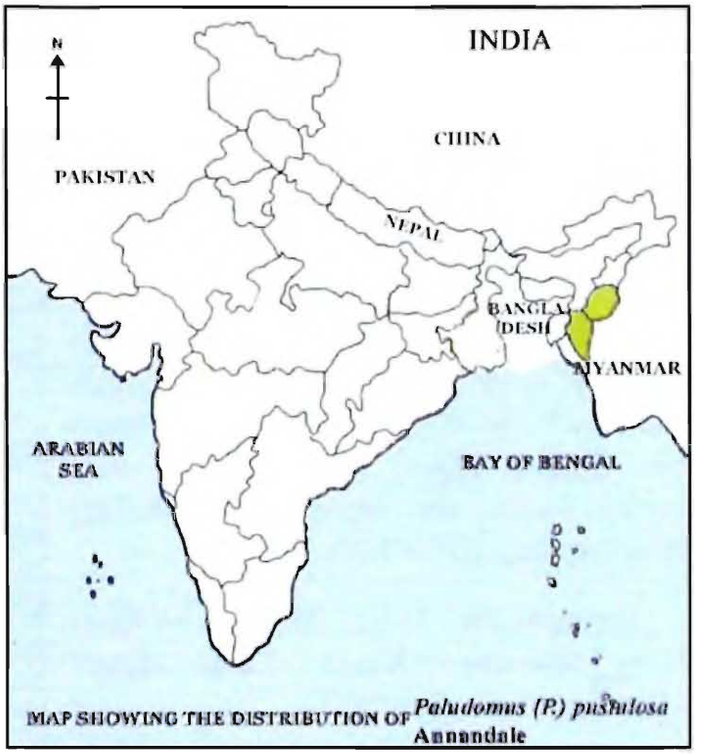
Fig. 130. B. Ventral view of *Paludomus (Paludomus) pustulosa* Annandale

Type location : National Zoological Collection, ZSI, Regd. No. M 11858/2 (Holotype) and M 11859/2 (Syntypes).

Latest name and Reference : *Paludomus (Paludomus) pustulosa* : Surya Rao, Mookherjee, Mitra, Manna and Barua 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 79. *Zool. Surv. India.*

Diagnosis : Shell ovate, thick and uniformly black, with a tumid body whorl; sculpture with coarser longitudinal lines, interior of the shell olivaceous, sometimes with traces of two or three broad chestnut bands.

Distribution : India : Manipur, Mizoram.



Paludomus (Paludomus) regulata Benson, 1856

1856. *Paludomus regulata* Benson, *Ann. Mag. Nat. Hist.* (2)**17** : 496. Type locality : Thyet-Myo, Myanmar.

1876. *Paludomus regulata* : Hanley and Theobald, *Conch. Indica* : pl. 108, fig. 5.

1877. *Paludomus andersoniana* : Nevill, *J. Asiat. Soc. Beng.*, **46**(2) : 35. Type locality : Upper Myanmar.

1989. *Paludomus (Paludomus) regulata* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 118, fig. 236.

Fig. 131. A. Dorsal view of *Paludomus (Paludomus) regulata* Benson

Fig. 131. B. Ventral view of *Paludomus (Paludomus) regulata* Benson

Type location : Not known.

Latest name and Reference : *Paludomus (Paludomus) regulata* : Subba Rao, Mitra, Dey and Maitra, 1989, *Fauna of Meghalaya, State Fauna Series* **4**(Part-8), p. 25. *Zool. Surv. India.*

Diagnosis : Shell large, ovately globose; spire sharp and pointed; suture deep; whorls 5; sculpture with groove like spiral ridges; body with 4 dark brown bands, the second from the top broader than the others.

Distribution : India : Meghalaya: Garo Hills (South), Khasi Hills (East); Mizoram, West Bengal.

Elsewhere : Myanmar.

Paludomus (Paludomus) reticulata Blanford, 1870

1870. *Paludomus reticulata* Blanford, *J. Asiat. Soc. Beng.*, **39**(2) : 9, pl. 3, fig. 1. Type locality : North cachar, Assam.

1989. *Paludomus (Paludomus) reticulata* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 117, fig. 237.

Fig. 132. A. Dorsal view of *Paludomus (Paludomus) reticulata* Blanford

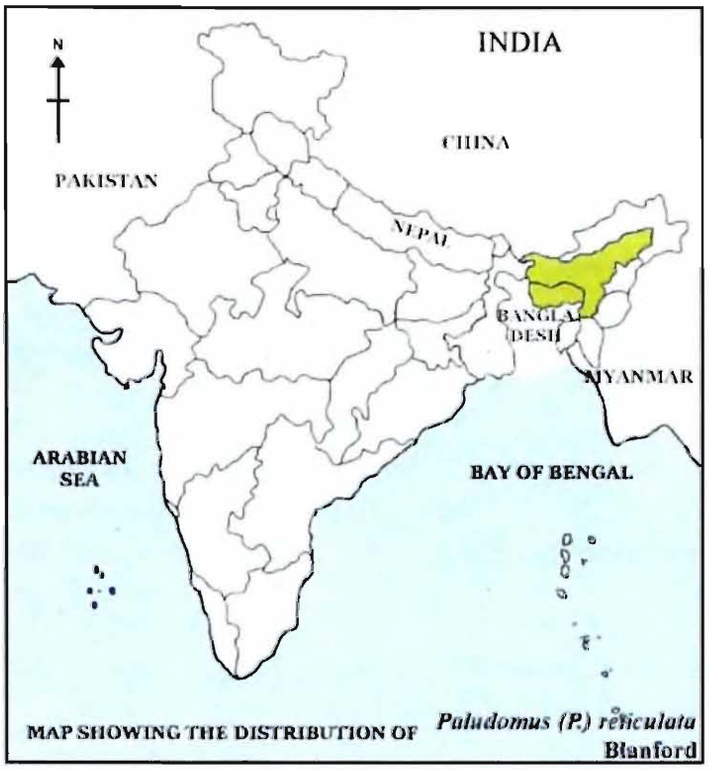
Fig. 132. B. Ventral view of *Paludomus (Paludomus) reticulata* Blanford

Type location : Not known.

Latest name and Reference : *Paludomus (Paludomus) reticulata* : Subba Rao, Mitra, Dey and Maitra, 1989, *Fauna of Meghalaya, State Fauna Series* **4**(Part-8), p. 25. *Zool. Surv. India.*

Diagnosis : Shell globose; suture impressed; whorls 3-4; sculpture with reticulate spiral striations, which form regular axial granules or reticulations.

Distribution : India : Assam, Meghalaya : Garo hills (West). Restricted to North east India only.



Paludomus (Paludomus) rotunda Blanford, 1870

1870. *Paludomus rotunda* Blanford, *J. Asiat. Soc. Beng.*, **39**(2) : 10, pl. 3, fig. 2. Type locality : Travancore.

Type location : Not known.

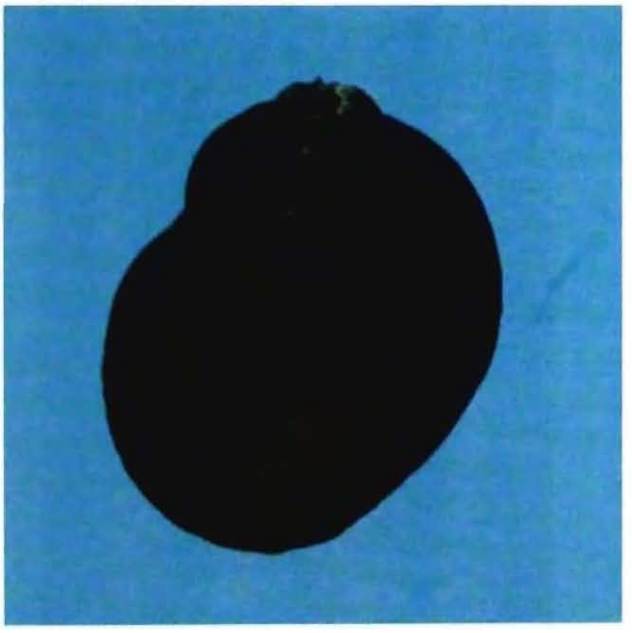


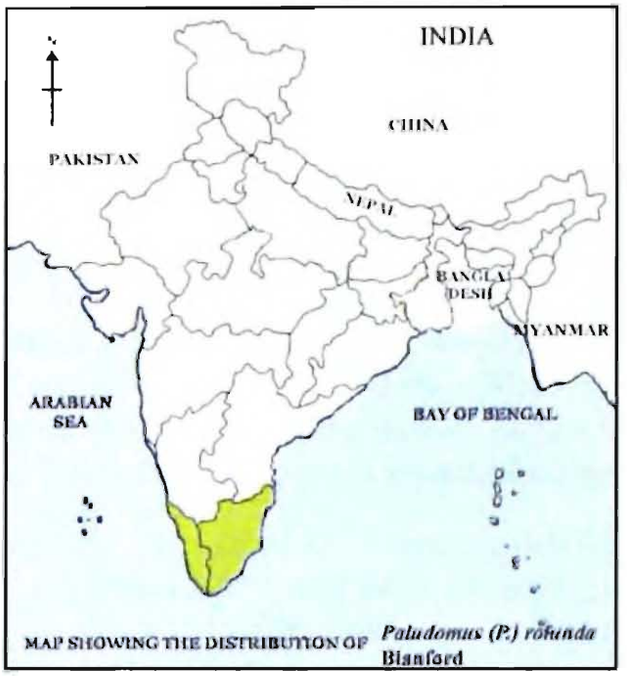
Fig. 133. A. Dorsal view of *Paludomus (Paludomus) rotunda* Blanford

Fig. 133. B. Ventral view of *Paludomus (Paludomus) rotunda* Blanford

Latest name and Reference : *Paludomus (Paludomus) rotunda* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 117, fig. 238.

Diagnosis : Shell small, oval, decollated, only two whorls seen; sculpture with irregular spiral striae; aperture suboval, columella arched, callus broad, outerlip sharp.

Distribution : India : Kerala : Western Ghats; Tamil Nadu : Balarangam, Anamullay and Madurai Hills.



Paludomus (Paludomus) stephanus (Benson, 1836)

1836. *Melania stephanus* Benson, *J. Asiat. Soc. Beng.*, **38** : 747. Type locality : Sylhet, Bangladesh.

1876. *Paludomus stephanus* : Hanley and Theobald, *Conch. Indica*, pl. 122, fig. 10.

1989. *Paludomus (Paludomus) stephanus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 117, figs. 240, 241.

Fig. 134. A. Dorsal view of *Paludomus (Paludomus) stephanus* (Benson)

Fig. 134. B. Ventral view of *Paludomus (Paludomus) stephanus* (Benson)

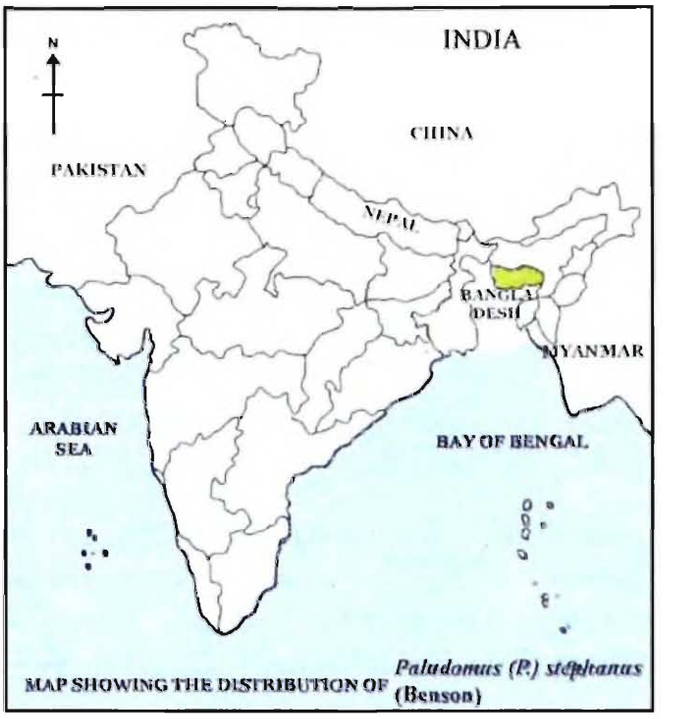
Type location : Not known.

Latest name and Reference : *Paludomus (Paludomus) stephanus* : Subba Rao, Mitra, Dey and Maitra, 1989, *Fauna of Meghalaya, State Fauna Series*, **4**(Part-8), p. 26. *Zool. Surv. India.*

Diagnosis : Shell ovately conical, with rapidly increasing whorls; spire short, decollated; body whorl very much inflated, whorls conspicuously shouldered bearing a crown of short and pointed spines; aperture oval; columella very much arched and produced below, outerlip angularly arched.

Distribution : India : Meghalaya : Khasi Hills (East and West), Jantia Hills.

Elsewhere : Bangladesh : Sylhet.



Paludomus (Paludomus) tanschauricus (Gmelin, 1771)

1791. *Helix tanschauricus* Gmelin, *Syst. Nat.*, ed. **13** : 3655. Refers to Chemnitz's *Syst. Conch. Cab.*, **9** : 174, figs. 1246, 1247.

1862. *Paludomus acutus* : Reeve, *Proc. zool. Soc. Lond.*, **1852** : 127. Type locality : Near Pondicherry.

1863. *Paludomus tanjoriensis* : Blanford (emend), *Trans. Linn. Soc. Lond.* : 173, pl. 27, figs. 2a-e.

1974. *Paludomus (Paludomus) tanschauricus* : Starmuehlner, *Bull. Fish. Res. Stn. Sri Lanka*, **25**(1-2) : 140, pl. 8, fig. 80.

1989. *Paludomus (Paludomus) transchauricus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 118, figs. 221, 252, 253.

Fig. 135. A. Dorsal view of *Paludomus (Paludomus) tanschauricus* (Gmelin)

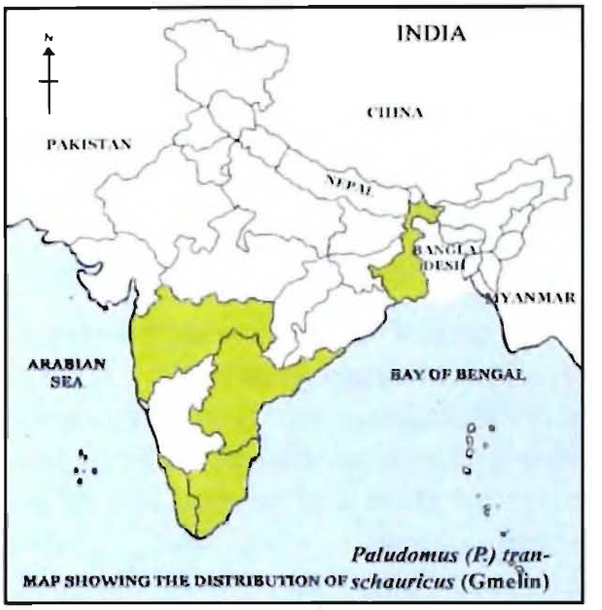
Fig. 135. B. Ventral view of *Paludomus (Paludomus) tanschauricus* (Gmelin)

Type location : Not known.

Latest name and Reference : *Paludomus transchauricus* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 201. *Zool. Surv. India.*

Diagnosis : Shell conical; whorls 6-8, convex, first few whorls with keeled spiral ridges; aperture ovate, posteriorly pointed; colour yellowish brown with dark brown spots running in lines and waves.

Distribution : India : Andhra Pradesh : Cuddapah; Kerala : Kottayam, Travancore, Malabar; Maharashtra : Pune; Tamil Nadu : Pulney Hills, Trichinnapally, Chennai; West Bengal.



MAP SHOWING THE DISTRIBUTION OF *Paludomus (P.) transchauricus* (Gmelin)

Elsewhere : Sri Lanka.

Subgenus ***Philopotamis*** Layard, 1855

1855. *Philopotamis* Layard, *Ann. Nat. Hist.*, (2)**16** : 134. Type species : *Paludomus sulcatus* Reeve.

This subgenus is similar with the subgenus *Paludomus* in all respects except the operculum which is a definite character of this Subgenus. Restricted to the fast flowing torrent and mountain streams of South west Sri Lanka and Sumatra (Starmuehlner, 1977). He also remarked that this subgenus endemic to Sri Lanka. This subgenus represented by one species from the hill streams of Western Ghat, India.

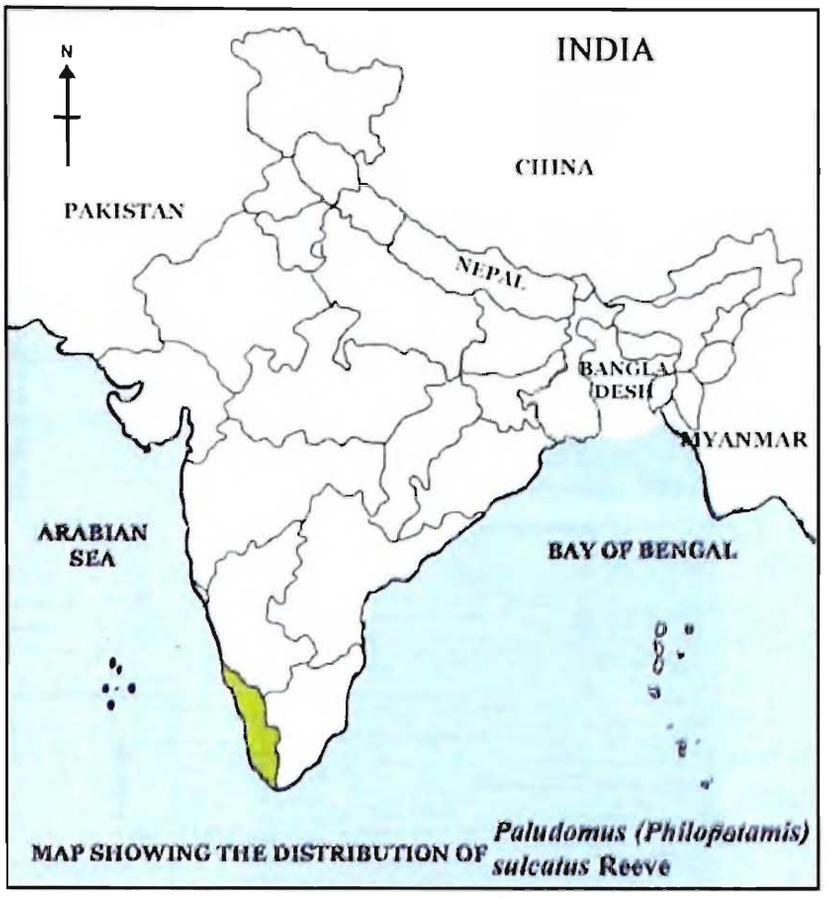
Paludomus (Philopotamis) sulcatus Reeve, 1847

1847. *Paludomus sulcatus* Reeve, *Conch. Icon.*, **4** : pl.2, fig., 8a, pl. 3, figs. 8b, 8c. Type locality : Stream at Ratnapoora, Sri Lanka.

Fig. 136. A. Dorsal view of *Paludomus (Philopotamis) sulcatus* Reeve

Fig. 136. B. Ventral view of *Paludomus (Philopotamis) sulcatus* Reeve

1974. *Paludomus (Philopotamis) sulcatus* : Starmuehlner, *Bull. Fish. Res. Stn. Sri Lanka*, **25**(1-2) : 145, pl. 9, fig. 89.



Type location : Natural History Museum, London.

Latest name and Reference : *Paludomus (Philopotamis) sulcatus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 120, fig. 243.

Diagnosis : Shell ovate, with prominent and eroded spire; whorls 3-5, rounded, very closely spirally grooved and intermediate ridges closely decussated with longitudinal stirae; suture impressed; sculpture with spiral grooves; aperture subtriangularly ovate, angulate posteriorly; operculum sub triangularly ovate, nucleus sub basal and dextral; colour yellowish olive, pointed with here and there with black, sometimes entrely black, interior whitish.

Distribution : India : Kerala.

Elsewhere : Sri Lanka.

Subgenus ***Stomatodon*** Benson, 1862

1862. *Stomatodon* Benson, *Ann. Mag. Nat. Hist.*, (3)**10** : 414. Type species : *Paludomus stomatodon* Benson

Shell ovately conical; spire rather low; aperture posteriorly angular; columellar margin broad and with distinct tooth anteriorly.

Restricted to Western Ghat, Kerala, India.

Paludomus (Stomatodon) stomatodon Benson, 1862

1862. *Paludomus (Stomatodon) stomatodon* Benson, *Ann. Mag. Nat. Hist.*, (3)**10** : 415. Type locality : Mountain streams near Cottayam (= Kottayam), Kerala.

1960. *Paludomus (Stomatodon) stomatodon* : Satyamurti, *Bull. Madras Govt. Museum*, (New series), *Nat. Hist. Soc.*, **6**(4) : 50, pl. vi, figs. 2a, 2b.

Fig. 137. A. Dorsal view of *Paludomus (Stomatodon) stomatodon* Benson

Fig. 137. B. Ventral view of *Paludomus (Stomatodon) stomatodon* Benson

Type location : Not known.

Latest name and Reference : *Paludomus (Stomatodon) stomatodon* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 122, fig. 242.

Diagnosis : Shell with a large and inflated body whorl; spire short and depressed; sutures well impressed, faint or often obsolete spiral striations; aperture ovate and angular posteriorly, columellar callus broad as in neritids and bears a prominent tooth-like projection on its anterior part, often with a blackish brown tinge on the upper part of the collumellar callus; Operculum horny, dark brown with excentric nucleus.

Distribution : India : Kerala : Near Kottyam, Travancore (Mountain streams).

Subgenus ***Tanalia*** Gray, 1847

1847. *Tanalia* Gray, *Proc. zool. Soc. Lond.*, **1847** : 153. Type species : *Nerita aculeata* Chemnitz.

Occurs in fast flowing torrents and mountain streams and endemic to Sri Lanka (Starmuehlner, 1977). But two species occurs from Assam and Kerala, India.

Key to the species

– Sculptured with prominent, nodulose spiral ridges ..... *P. (T.) loricatus* Reeve

– Sculptured with fine spiral ridges ..... *P. (T.) neritoides* Reeve

Paludomus (Tanalia) loricatus Reeve, 1847

1847. *Paludomus loricata* Reeve, *Conch. Icon.* **4** : *Paludomus* sp. no. 1, pl. 1, figs. 1a, b, c. Type locality : In rapids flowing stream from Adam's Peak, Sri Lanka.

1974. *Paludomus (Tanalia) loricatus* : Starmuehlner, *Bull. Fish. Res. Stn. Sri Lanka*, **25**(1-2) : 146, pl. 9, figs. 92-99, pl. 10, figs. 100-104.

Fig. 138. A. Dorsal view of *Paludomus (Tanalia) loricatus* Reeve

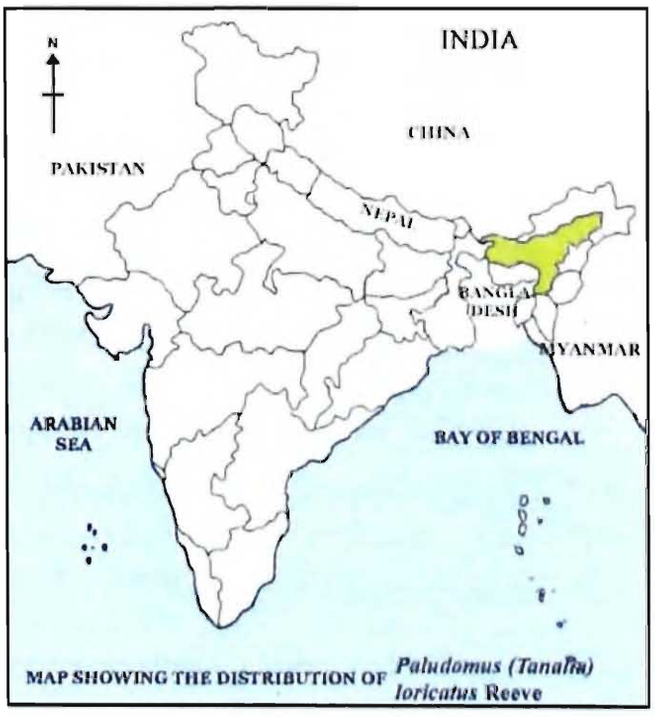
Fig. 138. B. Ventral view of *Paludomus (Tanalia) loricatus* Reeve

Type location : Not known.

Latest name and Reference : *Paludomus (Tanalia) loricatus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 121, fig. 230.

Diagnosis : Shell oblong ovate; spire scarecely exerted; whorls slightly angularly depressed round the upper part, spirally encircled with close set squamate ridges; aperture large; sculptured with characteristic nodulose spiral ridges, blackish brown, interior white, columella and edge of the lip purple brown.

Starmuehlner (1974) dealt the detail about the intra specific variations.



MAP SHOWING THE DISTRIBUTION OF *Paludomus (Tanalia) loricatus* Reeve

Distribution : India : Assam.

Elsewhere : Sri Lanka: In slightly acidic and slow flowing mountain streams (Starmuehlner, 1977).

Paludomus (Tanalia) neritoides Reeve, 1847

1847. *Paludomus neritoides* Reeve, *Conch. Icon.*, **4** : pl. 1, fig. 3. Type locality : In the bed of a river at Ambegamon, Sri Lanka.

1974. *Paludomus (Tanalia) neritoides* : Starmuehlner, *Bull. Fish. Res. Stn. Sri Lanka*, **25**(1-2) : 150, pl. 10, figs. 108-110, pl. 11, figs. 111-120, pl. 12, figs. 121-123.

Fig. 139. A. Dorsal view of *Paludomus (Tanalia) neritoides* Reeve

Fig. 139. B. Ventral view of *Paludomus (Tanalia) neritoides* Reeve

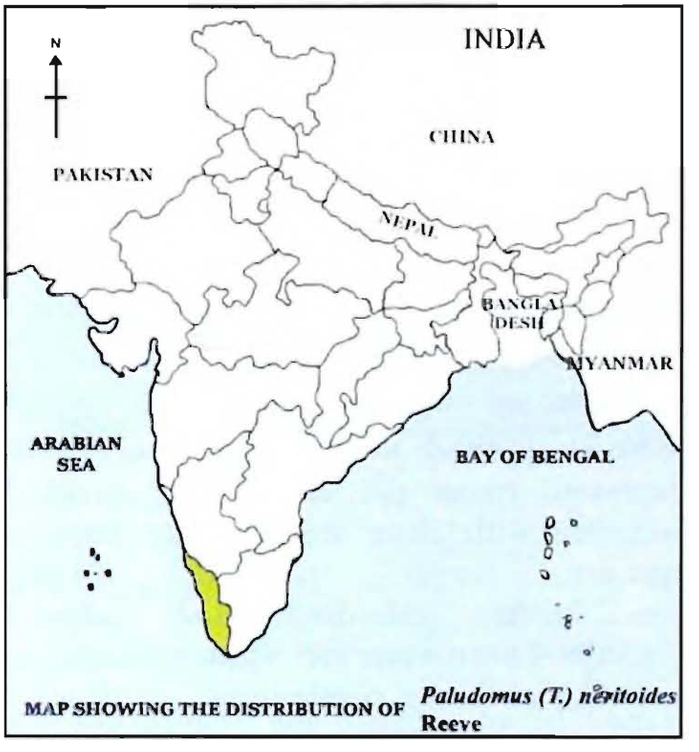
Type location : Not known.

Latest name and Reference : *Paludomus (Tanalia) neritoides* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 121, figs. 246-249.

Diagnosis : Shell oblong ovate, neritoid in shape, body whorl large; spire often depressed or exserted; sculpture with spiral ridges; aperture large with broad columellar callus, with purple black or blackish brown.

Starmuehlner, (1977) gave exhaustive synonymy, ecology and anatomy of this species.

Distribution : India : Kerala.



MAP SHOWING THE DISTRIBUTION OF *Paludomus (T.) neritoides* Reeve

Elsewhere : Sri Lanka : Southwest parts.

Subclass PULMONATA
Order BASOMMATOPHORA
Superfamily LYMNAEOIDEA
Family LYMNAEIDAE

Shell small to large, dextral, ovately oblong, thin and light, spire pointed and variable in height. Body whorl inflated and proportionately large, columellar axis typically twisted; aperture rather large, lip thin and simple.Tentacles flat and triangular; pseudobranch lacking. Stomach divided into three parts, the anterior oval crop, the middle stomach proper enclosed by the highly muscular bilobed gizzard, and the posterior tapering pylorous. Genital opening two, situated on the right side; copulatary organ with a slender penis sheath and simple penis. Eggs are deposited in clusters in enlarged gelatinous capsule.

World wide. Inhabitant of almost all types of freshwater habitats with or without vegetation.

Hubendick (1951) made a revision of recent Lymnaeidae using the biological species concept. Shell form, the distal part of genitalia, radula and the structure of prostate were the characters of his study. His study reduced the number of species from over a thousand to forty only. Burch and Lindsay (1973) used various techniques ranging from classical conchology to breeding studies and remarked that "classical taxonomic divisions within the family based on shell characters are more reliable than radular teeth or characters of the reproductive tracts (as previously used) *i.e.* our immunological studies correlated best with shell characters" Brown (1980) also remarked that "...but it seems justifiable to retain at least some subgenera"

Annandale and Rao (1925) made a revision of Indian Lymnaeidae and their conclusions are reliable to a large extent. Their observation shows that for Indian Lymnaeids much value could not be attached to anatomical or other characters.

The significant contributions of Indian species of this group were made by Agarwal (1977) on growth of *L. acuminata*; Brahmacharya *et al.* (1968, 1970, 1971 and 1977) on embryology; Das Gupta (1973, 1978) biology of parasiteic species; Das Gupta and Ghose (1977) on physiology; Dutt and Bali (1977) life history; George Michael (1966) development; Nagabhushanam and Azantunnisa (1977) temperature tolerance; Patnaik (1968, 1971) and Patnaik and Ray (1967, 1968) an histopathology, ecology and distribution; Seshaiya (1928) breeding habits and fecundity.

Lymnaeidae a large family of freshwater gastropods distributed throughout the world. Hubendick (1951) has monographed the family on a world basis. The Lymnaeidae have conical dextral shells with pneumostome and separate male and female gonophores on the right side.The shell shape is highly variable but usually expanded body whorl and a wide aperture. The systematics of this family is highly confused because of the extreme variability.

Genus ***Lymnaea*** Lamarck, 1799

1799. *Lymnaea* Lamarck, *Prodr. Nouv. Clas. Coq.* : 75. Type species : *L. stagnalis* Linnaeus.

Shell thin, ovate or enongate, rimate or imperferate; spire exerted; body whorl large; aperture oval, pristome thin and simple; columella spirally twisted; mantle not extending over the shell.

The systematics of the genus *Lymnaea* is still in a confused state. On the basis of the extremely variable shell characters a large number of species and subspecfic forms were described by various authors. Hubendick (1951) made a revisionary study of the family based on the anatomical characters and as a result of it the number of species and forms were drastically brought down. Burch and Lindsay (1973) proved that classical taxonomic revisions within the family based on the shell characters are more reliable.

Key to the species

1. Shell small less than (10mm), rather slender and delicate, narrow with blunt apex ..... *L. horae* Annandale and Rao

– Shell more than 10 mm, not so delicate ..... (2)

2. Spire with 5 complete whorls ..... *L. stagnalis* (Linnaeus)

– Spire with not more than 4 complete whorls ..... (3)

3. Spire very short, atleast 3 times as broad at the base as high ..... *L. ovalior* Annandale and Prashad

– Spire longer much less than 3 times as broad at the base as high ..... (4)

4. Spire acuminate, outer lip very much expanded and convex in outline ..... (5)

– Spire less acuminate, outerlip not very much expanded and almost straight in ouitline ..... *L. (P) luteda* Lamarck

5. Outer lip pointed below resulting spindle shaped or acuminate at both end ..... *L. (P.) biacuminata* Annandale and Rao

– Outer lip not pointed or not spindle shaped or acuminate at both end ..... *L.(P.) acuminata* Lamarck

Subgenus ***Lymnaea*** s.st.

Lymnaea (Lymnaea) stagnalis (Linnaeus, 1758)

1758. *Helix stagnalis* Linnaeus, *Syst. Nat., ed.* **10** : 774. Type locality : Sweden.

1925. *Limnaea stagnalis* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 147. fig. V-7 to 10.

Fig. 140. A. Dorsal view of *Lymnaea (Lymnaea) stagnalis* (Linnaeus)

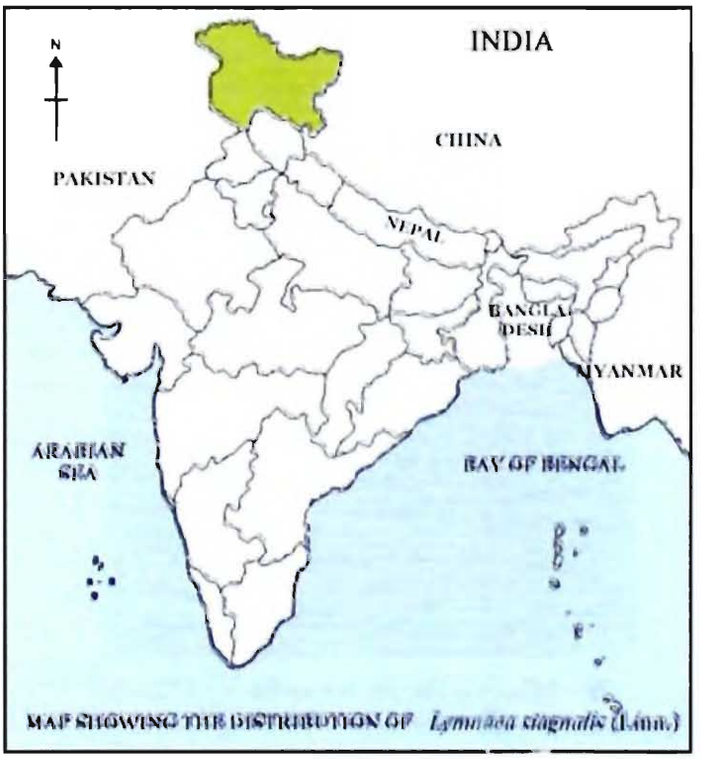
Fig. 140. B. Ventral view of *Lymnaea (Lymnaea) stagnalis* (Linnaeus)

Type location : Not known.

Latest name and Reference : *Lymnaea stagnalis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 135, figs. 292, 293.

Diagnosis : Shell ovately turreted, compressely umbilicated, rather thin, yellowish horny, spire produced and sharply acuminated; whorls 5-6, sloping convex round the upper part, then ventricose, striated in the direction of the line of growth, sometimes evanescently obscurely irregularly ridged and malleated in the opposite direction; aperture moderate, somewhat squarely ovate, columella callously twisted, lip broadly adpressedly dilated over the umbilicus.

Hubendick (1951) described detail of genetalia of this species.



Distribution : India : Kashmir.

Elsewhere : Its range extends over almost the whole of Europe and the Western Parts of North Africa, Asia Minor, Syria, Iran and North America, New Zealand. Absent in Greenland and Iceland.

Subgenus ***Pseudosuccinea*** Baker, 1908

1908. *Pseudosuccinea* Baker, *Science, New York*, **27** : 943. Type species, *Lymnaea columella* Say.

Shell succineiform. Prostrate unfolded.

Lymnaea (Pseudusuccinea) acuminata Lamarck, 1822

1822. *Limnaea acuminata* Lamarck, *Hist. nat. Anim. Sans. Vert.*, **6**(2) : 160. Type locality : "Bengal"

1925. *Limnaea acuminata* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 177.

form ***typica*** Lamarck, 1822

1822. *Limnaea acuminata* Lamarck, *Hist. nat. Anim. Sans. Vert.*, **6**(2) : 160.

1925. *Limnaea acuminata* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 177.

1989. *Lymnaea acuminata* form *typica* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 127, figs. 258, 259.

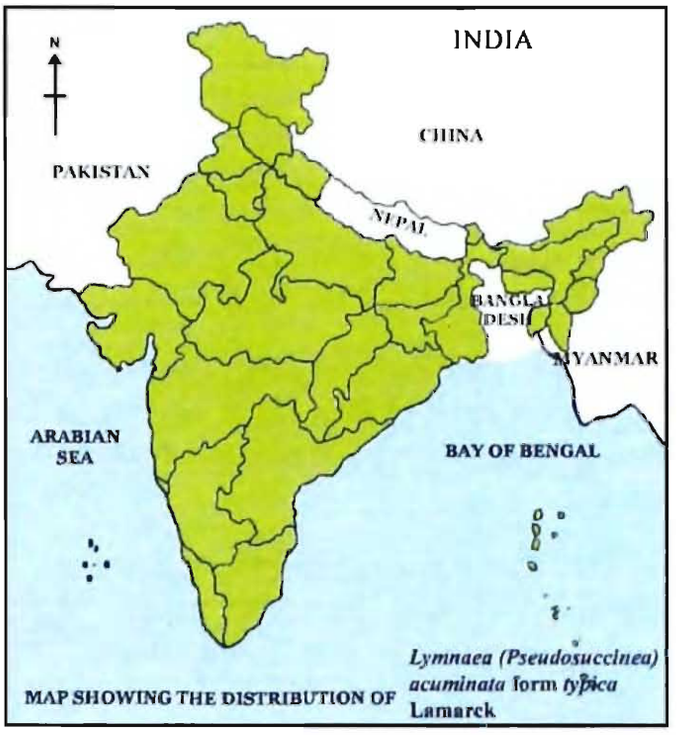
Fig. 141. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***typica*** Lamarck

Fig. 141. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***typica*** Lamarck

Type location : Natural History Museum, London.

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* f. *typica*: : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 203. *Zool. Surv. India.*

Diagnosis : Shell thin, ovate, spire short, acuminate, body whorl much inflated, a little angular above, with a large aperture.



Remark : This species usually occurs in permanent water bodies with abundant vegetations.

Larval forms of some important parasites of sheep, cattle and man are recorded from this snail. It is an intermediate host of different fluke's *viz. Fasciola gigantica, F. hepatica, Schistosoma indica, S. nasalis, S. spindalis* and *Clinostomum giganticum, Echinostoma* sp.

Distribution : India : Throughtout.

form ***brevissima*** Annandale and Rao, 1925

1925. *Limnaea brevissima* Annandale and Rao, *Rec. Indian Mus.*, **27** : 182, fig. III-1. Type locality : Nagpur, India.

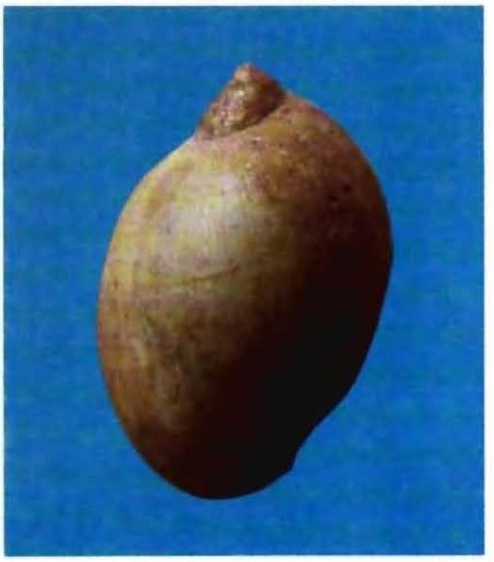


Fig. 142. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***brevissima*** Annandale and Rao

Fig. 142. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***brevissima*** Annandale and Rao

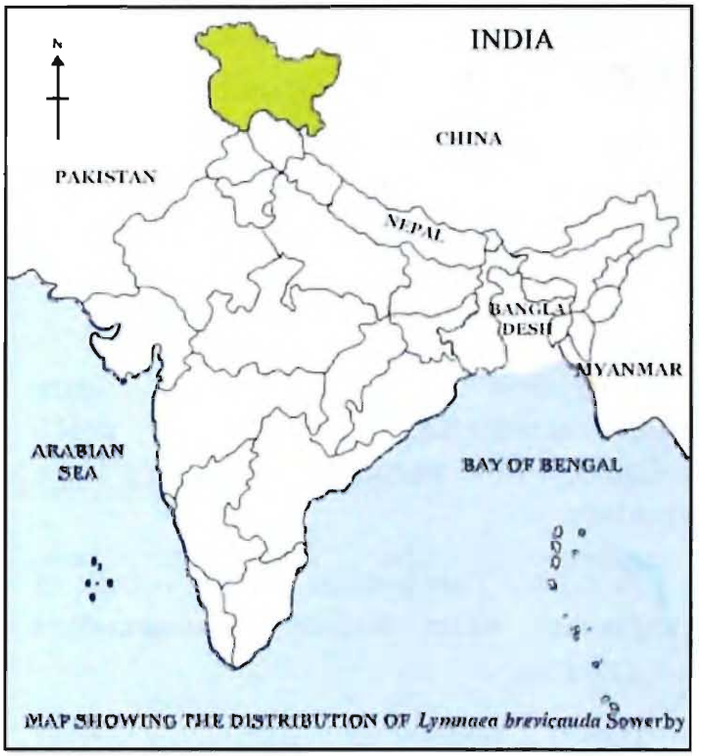
Type location : National Zoological Collection, ZSI, Reg. No. M 12476/2 (Syntypes).

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* form *brevissima* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 127.

Diagnosis : Shell regularly ovate; spire very short of less than three whorls and broad; sculpture with fine curved vertical lines.

This form is very closely related to *L. acuminata typica* Lamarck except the depressed spire. It may be an abnormal form of *typica*.

Distribution : India : Maharashtra.



MAP SHOWING THE DISTRIBUTION OF *Lymnaea brevicauda* Sowerby

form ***chlamys*** Benson, 1836

1836. *Lymnaea chlamys* Benson, *J. Asiat. Soc. Beng.*, **5** : 744. Type locality : Moradabad.

1989. *Lymnaea (Pseudusuccinea) acuminata form chlamys* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 127.

Fig. 143. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***chlamys*** Benson

Fig. 143. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***chlamys*** Benson

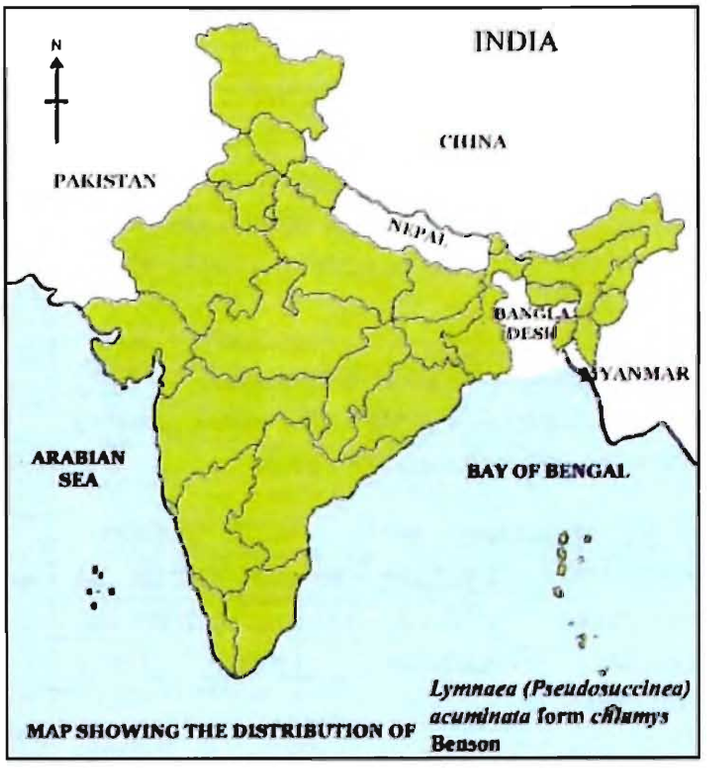
Type location : Not Known.

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* f. *chlamys* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 82. *Zool. Surv. India.*

Diagnosis : Spire a little larger but narrower than in typica, columella more twisted, colour usually golden yellow.

Distribution : India : Widely occurs throughout India;

Elsewhere : Bangladesh; Myanmar.



form ***gracilior*** Martens, 1881

1881. *Limnaea acuminata* var. *gracilior* Martens, *Conch Mittheil*, **1** : 77. Type locality : Bengal.

1989. *Lymnaea (Pseudusuccinea) acuminata* form *gracilior* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 127, figs. 262, 263.

Fig. 144. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***gracilior*** Martens

Fig. 144. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***gracilior*** Martens

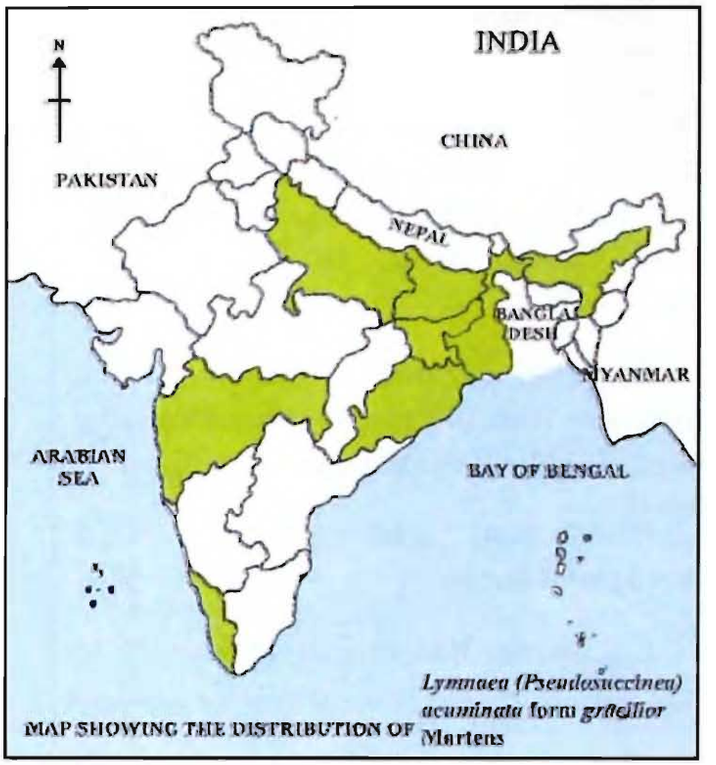
Type location : Not Known.

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* form *gracilior* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 203. *Zool. Surv. India.*

Diagnosis : Shell linear with a long narrow spire, colour of shell varies between greyish to light pink.

Distribution : India : West Bengal : Bardhaman, Kolkata, Hugli, North 24 Paraganas, Puruliya; Assam, Jharkhand, Kerala, Maharashtra, Orissa, Uttar Pradesh.

Elsewhere : Myanmar.



form ***hians*** Sowerby, 1873

1873. *Limnaea acuminata* form *hians* Sowerby in Reeve, *Conch. Icon.*, **18** : sp. no. 57. Type locality : "Malabar."

Fig. 145. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form *hians* Sowerby

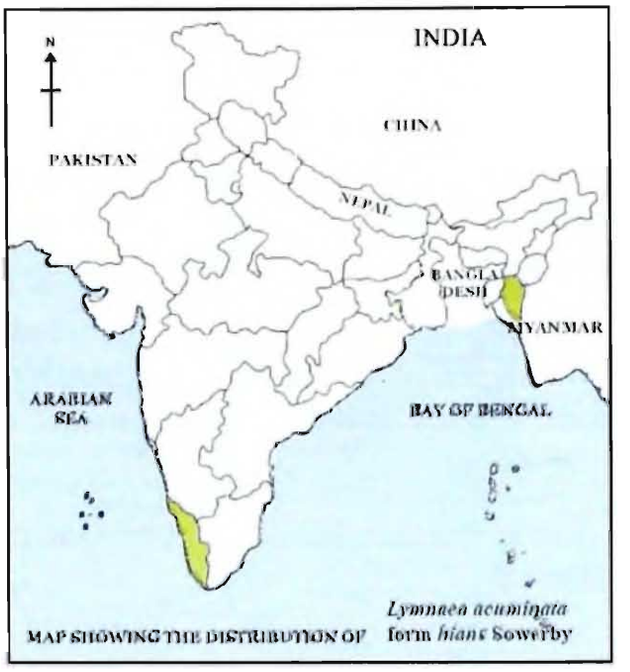
Fig. 145. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form *hians* Sowerby

Type location : Not Known.

Latest name and Reference : *Lymnaea acuminata* form *hians* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 127, figs. 264, 265.

Diagnosis : Shell ovate dwarf, spire high and narrow; body whorl inflated and little angular; aperture large

Distribution : India : Kerala : Malabar; Mizoram.



form ***malleata*** Annandale and Rao, 1925

1925. *Limnaea acuminata* form *malleata* Annandale and Rao, *Rec. Indian Mus.*, **27** : 182, fig. III-8. Type locality : Punjab, India.

Type location : Not known.

Fig. 146. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***malleata*** Annandale and Rao

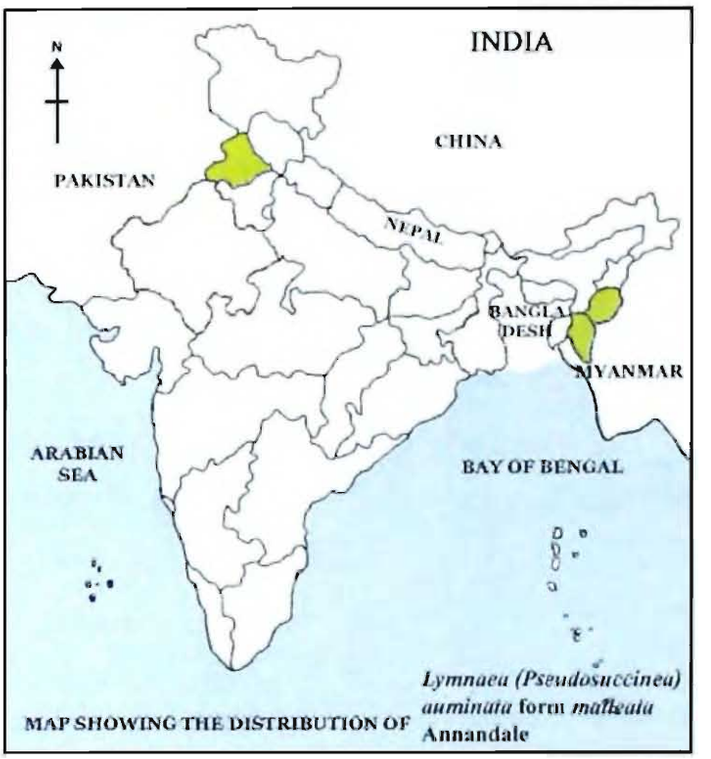
Fig. 146. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***malleata*** Annandale and Rao

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* form *malleata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 127, figs. 260, 261.

Diagnosis : Shell very similar to the preceding form but can be readily distinnguished by its typical texture and well defined malleated sculpture of the bodywhorl

Distribution : India : Punjab; Manipur; Mizoram.

Elsewhere : Pakistan.



form ***patula*** (Troschel, 1837)

1836. *Limnaea acuminata patula* Troschel, in Weigman's *Archiv. fur. Naturg.*, **3** : 167. Type locality : River Ganges, India.

Fig. 147. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***patula*** (Troschel)

Fig. 147. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***patula*** (Troschel)

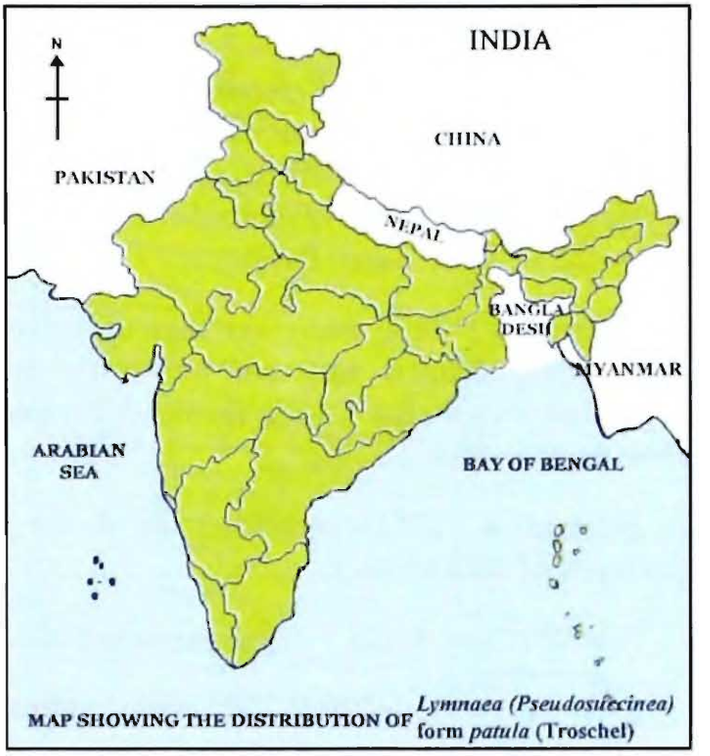
Type location : Not Known

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* form *patula* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 127, figs. 256, 257.

Diagnosis : Shell narrower than in *typica*, spire relatively large, anterior extremity of aperture tapering.

Distribution : India : Widely occurs throughout India.

Elsewhere : Pakistan, Nepal, Myanmar.



form ***rufescens*** Gray, 1822

1822. *Limnaea acuminata* f. *rufescens* Gray in Sowerby, *Gen. Rec. Foss. Shells*, **1** : pl. 178, fig. 2. Type locality : India.

1829. *Lymnaea (Pseudosuccinea) acuminata* f. *tonapii* : Ray and Roychowdhuri, *Proc. zool. Soc. Calcutta*, **22**(1) : 47-48, figs. 1-2. Type locality, Mula Multha river, Poona, Maharashtra.

1989. *Lymnaea (Pseudusuccinea) acuminata* form *rufescens* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 127, figs. 254, 255.

Fig. 148. A. Dorsal view of *Lymnaea (Pseudusuccinea) acuminata* form ***rufescens*** Gray

Fig. 148. B. Ventral view of *Lymnaea (Pseudusuccinea) acuminata* form ***rufescens*** Gray

Type location : MNHN.

Latest name and Reference : *Lymnaea (Pseudusuccinea) acuminata* form *rufescens* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 203. *Zool. Surv. India.*

Diagnosis : Shell narrower than in typical form, spire longer, aperture uniformly less expanded; columellar fold is feebly developed; reddish in colour.

Hubendick (1951) described the detail of genitalia of this species.

Distribution : India : Throughout India

Elsewhere : Bangladesh, Myanmar, Pakistan.

Echinostoma revolutum, E. malayanum, Fasciola hepatica and *Orientobilharzia turkestanicum* parasites are recorded from this snail.

Lymnaea (Pseudosuccinea) biacuminata Annandale and Rao, 1925

1925. *Limnaea biacuminata* Annandale and Rao, *Rec. Indian Mus.* **27** : 182. fig. III-2. Type locality : Hyderabad, Andhra Pradesh.

1989. *Lymnaea (Pseudusuccinea) biacuminata* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 128, figs. 277, 278.

Fig. 149. A. Dorsal view of *Lymnaea (Pseudosuccinea) biacuminata* Annandale and Rao

Fig. 149. B. Ventral view of *Lymnaea (Pseudosuccinea) biacuminata* Annandale and Rao

Type location : National Zoological Collection, ZSI, Regd. No. M 12466/ 2(Syntypes).

Latest name and Reference : *Lymnaea (Pseudusuccinea) biacuminata* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 204. *Zool. Surv. India.*

Diagnosis : Shell thin, fragile, narrow and elongate spindle shaped; aperture large, ovoid; columella slightly twisted and has a broad fold; umbilicus completely occuluded; sculptured with curved longitudinal striae; pale luteous in colour.

MAP SHOWING THE DISTRIBUTION OF *Lymnaea (Pseudosuccinea) biacuminata* Annandale

This species differs from *L. acuminata* in having the outer lip pointed below resulting in the shell being spindle shaped or acuminate at both ends.

Distribution : India : Andhra Pradesh : Secunderabad, Hyderabad; Uttaranchal : Kumaon, Nainital.

Remark : This species is known by types only and may be a synonym of *L. acuminata* form *rufescens* with a little variation.

Lymnaea (Pseudosuccinea) horae Annandale and Rao, 1925

1925. *Lymnaea horae* Annandale and Rao, *Rec. Indian Mus.*, **27** : 176, fig.11. Type locality : Thumarkur nullah, near Railway bridge, Sorupeta, Assam.

1925. *Lymnaea horae* f. *latior* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 176. Type locality : Jaulah Lake, Amingaon, Assam.

Fig. 150. A. Dorsal view of *Lymnaea (Pseudosuccinea) horae* Annandale and Rao

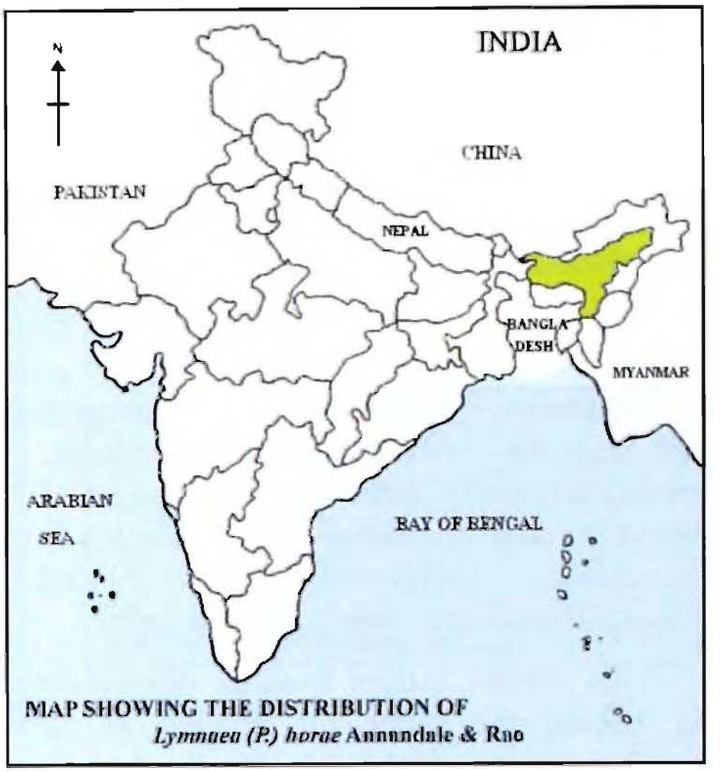
Fig. 150. B. Ventral view of *Lymnaea (Pseudosuccinea) horae* Annandale and Rao

Type location : National Zoological Collection, ZSI, Regd. No. M 12841/2.

Latest name and Reference : *Lymnaea (Pseudosuccinea) horae* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 130, figs. 273, 274.

Diagnosis : Shell with well developed and broader spire, with an extra half whorl of the apex; sculptured minutely decussated with numerous, close set of longitudinal striae; radula well developed; teeth shorter and broader.

Found in clear water with muddy substratum, on rotten twigs of trees which were floating in water or partly embedded in mud at the bottom.



Remark : Allied to *L. mimetica* but difers from it by having well developed spire; absence of columellar callus; sculpture with numerous close-set longigitudinal striae and much longer spermatheca.

Hubendick (1951) considered it as a transitional form between race *swinhoei* and race *rufescens* of *L. auricularia*.

Distribution : Not known beyond type locality.

Lymnaea (Pseudosuccinea) luteola Lamarck, 1822

1822. *Limnaea luteola* Lamarck, *Hist.nat. Anim. Sans. Vert.*, **6**(2) : 160. Type locality : Bengal.

1925. *Limnaea luteola* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 183.

Diagnosis : Shell thin, glossy, body whorl less inflated and laterally compressed a little; spire comparately longer and gradually tapering; aperture angulately narrows above.

Annandale and Rao (1925) described the jaw, radula and genitalia and Hubendick (1951) detail of genitalia of this species.

Remarks : This speices very found in particulars habitat. It is often found in temporary water bodies which dry up in summer and overcome the unfavourable conditions by burrowing in the mud. This species is less variable than the *L. acuminata*. It is considered as pest of paddy and *Azola*.

It is one of the important snails serving as intermediate host of some parasites of cattle, pig, dog etc. The parasites recorded are *Clinostomum giganticum, Echinoparyphium bugulai, Echinostoma revolutum, Fasciola gigantica, F. hepatica, Orientobilharzia dattai, Schistosoma incognitum, S. nasalis, S. spindalis,* and *S. sios.*

form ***typica*** Lamarck, 1822

1822. *Limnaea luteola* Lamark, *Hist. nat. Anim. Sans. Vert.*, **6**(2) : 160. Type locality : Pondicherry.

1925. *Limnaea luteola* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 183.

1989. *Lymnaea (Pseudusuccinea) luteola* form *typica* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 129, figs. 275, 276.

Fig. 151. A. Dorsal view of *Lymnaea (Pseudosuccinea) luteola* Lamarck

Fig. 151. B. Ventral view of *Lymnaea (Pseudosuccinea) luteola* Lamarck

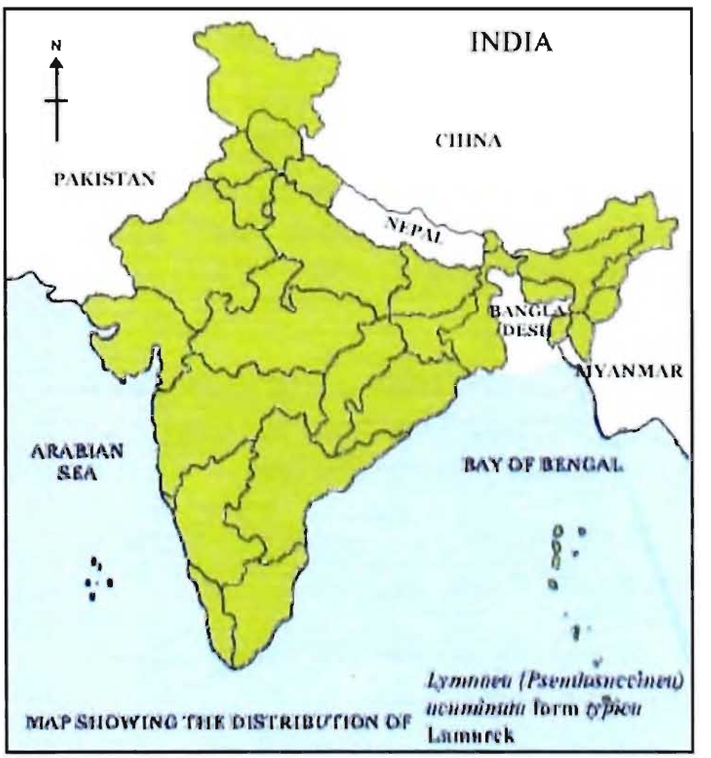
Type location : MNHN.

Latest name and Reference : *Lymnaea (Pseudusuccinea) luteola* form *typica* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 204. *Zool. Surv. India.*

Diagnosis : Shell less inflated, thin and glossy, relatively smaller and laterally compressed, spire gradually tapering and more produced, aperture narrow.

Distribution : India : Throughout India

Elsewhere : Bangladesh, Myanmar, Nepal, Pakistan.



form ***australis*** Annandale and Rao, 1925

1925. *Limnaea (Pseudosuccinea) luteola* f. *australis* Annandale and Rao, *Rec. Indian Mus.*, **27** : 184, fig. V-3. Type locality : India.

1989. *Lymnaea (Pseudusuccinea) luteola* form *australis* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 129, figs. 279, 280.

Fig. 152. A. Dorsal view of *Lymnaea (Pseudosuccinea)* form ***australis*** Annandale and Rao

Fig. 152. B. Ventral view of *Lymnaea (Pseudosuccinea)* form ***australis*** Annandale and Rao

Type location : Not known.

Latest name and Reference : *Lymnaea (Pseudusuccinea) luteola* form *australis*: : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), . 205. *Zool. Surv. India.*

Diagnosis : Shell smaller than *typica*, spire comparatively longer, last whorl well rounded, suture shallow.

Distribution : India : Common throughout India

Elsewhere : Pakistan; Sri Lanka; Bangladesh; Myanmar

MAP SHOWING THE DISTRIBUTION OF

form ***impura*** Troschel, 1837

1837. *Limnaea luteola* f. *impura* Troschel, *Arch. Naturgesch.*, **3** : 172. Type locality : River Ganges, India.

1989. *Lymnaea (Pseudusuccinea) luteola* form *impura* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 129, figs. 281, 282.

Fig. 153. A. Dorsal view of *Lymnaea (Pseudosuccinea)* form *impura* Troschel

Fig. 153. B. Ventral view of *Lymnaea (Pseudosuccinea)* form *impura* Troschel

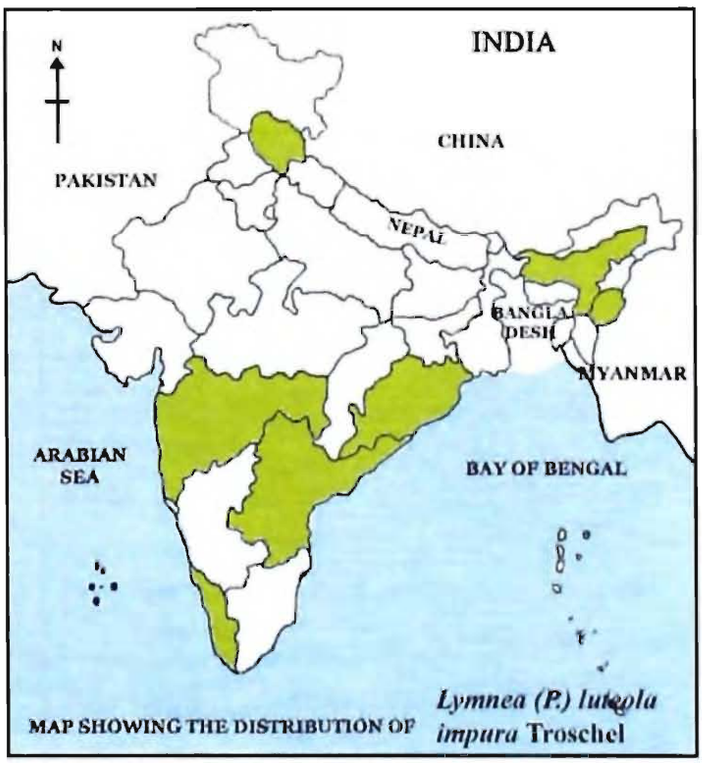
Type location : Not Known.

Latest name and Reference : *Lymnaea (Pseudusuccinea) luteola* form *impura* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 205. *Zool. Surv. India.*

Diagnosis : Shell smaller than *typica*, spire comparatively longer, last whorl well rounded, suture shallow.

Distribution : India : Andhra Pradesh, Assam, Himachal Pradesh, Kerala, Maharashtra, Nagaland, Orissa.

Elsewhere : Myanmar, Sri Lanka.



form *ovalis* Gray, 1822

1822. *Limnaea ovalis* Gray, in Sowerby's *Gen. Rec. Foss. Shells* : pl. 178. Type locality : East Indies.

1989. *Lymnaea (Pseudusuccinea) luteola* form *ovalis* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 129, figs. 266, 267, 283, 284.

Fig. 154. A. Dorsal view of *Lymnaea (Pseudosuccinea)* form *ovalis* Gray

Fig. 154. B. Ventral view of *Lymnaea (Pseudosuccinea)* form *ovalis* Gray

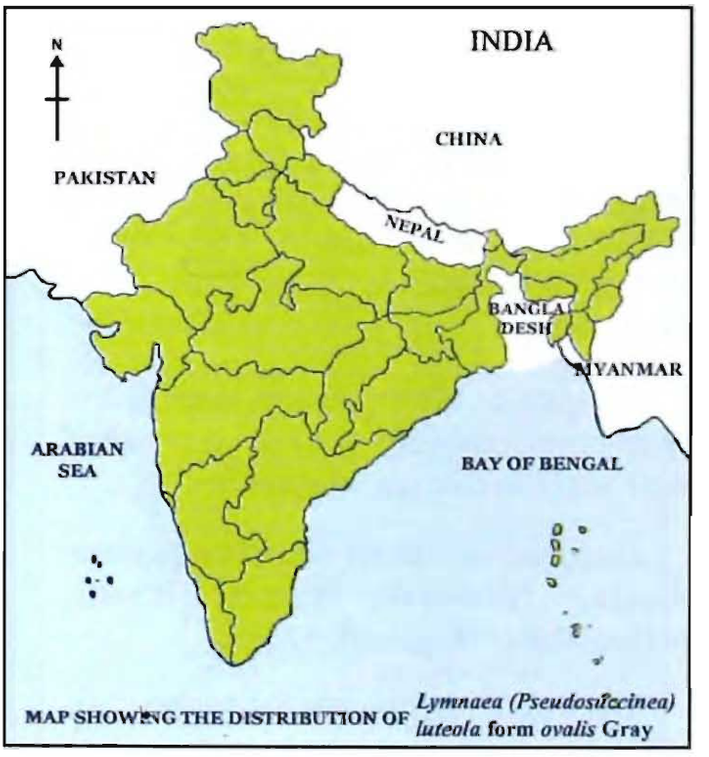
Type location : Natural History Museum, London.

Latest name and Reference : *Lymnaea (Pseudusuccinea) luteola* form *ovalis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part 5), p. 206. *Zool. Surv. India.*

Diagnosis : Shell larger than in preceeding species, last whorl much inflated without any compression, spire short and abruptly acuminate.

Distribution : India : Common throughout India.

Elsewhere : East Indies, Myanmar, Sri Lanka.



form ***succinea*** Deshayes, 1834

1834. *Limnaea luteola* f. *succinea* Deshayes, *Voy. Belang. Zool.*, p. 418. Type locality : Malabar Coast.

Fig. 155. A. Dorsal view of *Lymnaea (Pseudosuccinea)* form *succinea* Deshayes

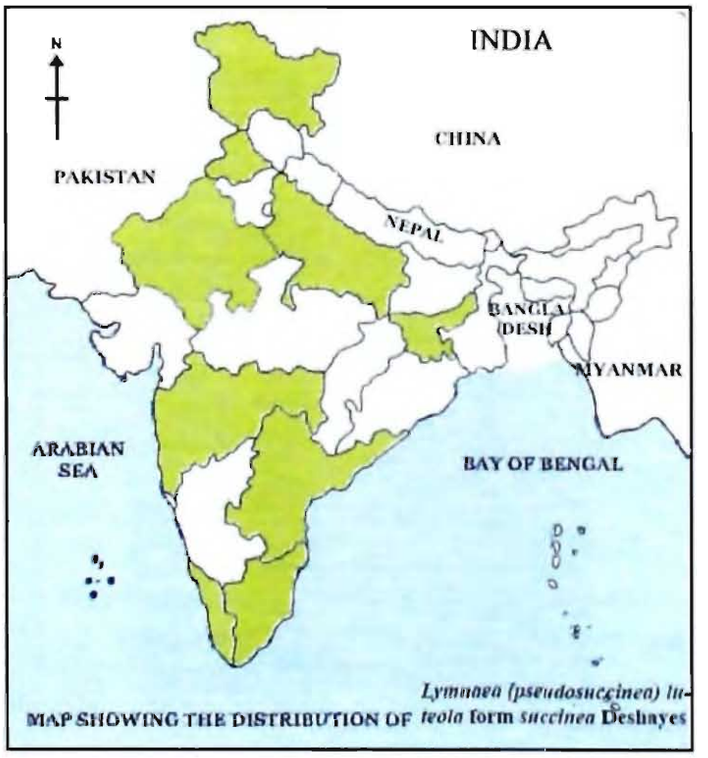
Fig. 155. B. Ventral view of *Lymnaea (Pseudosuccinea)* form *succinea* Deshayes

Type location : Natural History Museum, London.

Latest name and Reference : *Lymnaea (Pseudusuccinea) luteola* form *succinea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 129, figs. 286, 287.

Diagnosis : Shell larger than in preceeding species, last whorl much inflated without any compression, spire short and abruptly acuminate; columellar fold ordinarily pronounced; inner lip of different width.

Hubendick (1951) described detail of genitalia of this species.



Distribution : India : Andhra Pradesh : Godavari Town, Husain sagar, Kurnool, Secunderabad; Jharkhand: Ranchi; Hazaribagh; Kashmir: Harawan, Kokarnag, Srinagar; Kerala : Malabar coast; Maharashtra : Andheri (Mumbai); Punjab, Rajasthan : Udaipur; Tamil Nadu : Chennai (Coonoor, Palni hills); Uttar Pradesh : Baijnath, Sarnath.

Elsewhere : Java.

Lymnaea (Pseudosuccinea) ovalior Annandale and Prashad, 1921

1921. *Limnaea ovalior* Annandale and Prashad, *Rec. Indian Mus.*, **22** : 572, fig. 13A, pl. vii, figs. 4-6. Type locality : Loktak Lake, Manipur.

Fig. 156. A. Dorsal view of *Lymnaea (Pseudosuccinea) ovalior* Annandale and Prashad

Fig. 156. B. Ventral view of *Lymnaea (Pseudosuccinea) ovalior* Annandale and Prashad

Type location : National Zoological Collection, ZSI, Regd. No. M 11717/2.

Latest name and Reference : *Lymnaea ovalior* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 129, fig. 285.

Diagnosis : Shell globose, oviform with a short spire. The base of the spire as broad as upper portion of the body wall.

Distribution : India : Manipur (Bishenpur).

Elsewhere : Myanmar.

Annandale and Prasad (1921) and Annandale and Rao (1925) described the radula; Hubendick (1951) described the genetalia.

MAP SHOWING THE DISTRIBUTION OF *Lymnaea ovalior* Annandale & Prashad

Genus ***Galba*** Schranck, 1803

1803. *Galba* Schranck, *Fauna Boica*, **3**(2) : 262. Type species : *L. truncatula* Mueller.

Shell medium, comparatively narrow with long or moderate spire ; bodywhorl not reflected or expanded, outer lip not inflated; coluemllar fold with broad and coarse; radula with tricuspid laterals; mesocone exceptionally long and with base of the tooth; endocone reduced; genatalia as in *Radix*.

Key to the species

1. Spire whorls gradually increasing, basal whorl of spire not twice as broad as the one above it ..... (2)

– Spire whorls not gradually increasing, basal whorl of spire more than twice as broad as the one above it ..... *G.. hoookeri* (Reeve)

2 Spire and body whorl subequal in dorsal view ..... *G.. truncatula* (Mueller)

– Spire much smaller than body whorl ..... *G.. andersoniana* (Nevill)

Galba andersoniana Nevill, 1887

1887. *Limnaea andersoniana* Nevill, *J. Asiat. Soc. Beng.*, **46** : 26. Type locality : Nantin, Yunnan.

1925. *Lymnaea andersoniana* Annandale and Rao, *Rec. Indian Mus.*, **27** : 163.

1989. *Lymnaea andersoniana*: Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 132, figs. 268, 269, 310.

Fig. 157. A. Dorsal view of *Galba andersoniana* Nevill

Fig. 157. B. Ventral view of *Galba andersoniana* Nevill

Type location : Natural History Museum, London; National Zoological Collection, ZSI, Regd. No. M 12426/2 & M 12427/2 (Syntypes).

Latest name and Reference : *Lymnaea (Galba) andersoniana* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, Fauna of Manipur, *State Fauna Series*, **10**, p. 82. *Zool. Surv. India.*

Diagnosis : Shell small, globosely elongate, perforate, smooth, whorls 5, body whorl large and inflated, spire proportionately very short, suture impressed, aperture large, ovate, columellar margin thickened and reflected covering the perforation.

Annandale and Rao (1925) figured the jaw and radula of *L. andersoniana*. Central teeth of radula are aysmmetrical and having only one cusp. The first laterals are tricuspid, but the endocone is very small and scarcely visible. Hubendick (1951) described the detail of genetalia of this species.

Distribution : India : Himachal Pradesh : Simla Hills, Kashgar, Kangra valley; Kashmir : Ladak; Manipur : Bishenpur, Chandel, Churachandpur, Thoubal.

Elsewhere : Nepal valley; China : Southern Shan States; Myanmar : Yunnan.

Galba hookeri (Reeve, 1850)

1850. *Limnaea hookeri* Reeve, *Proc. zool. Soc. Lond.*, **18** : 49. Type locality : North side of Sikkim Himalaya, Tibet.

1925. *Lymnaea hookeri* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 167, fig. V-7.

1989. *Lymnaea hookeri* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 132.

Fig. 158. A. Dorsal view of *Galba hookeri* (Reeve)

Fig. 158. B. Ventral view of *Galba hookeri* (Reeve)

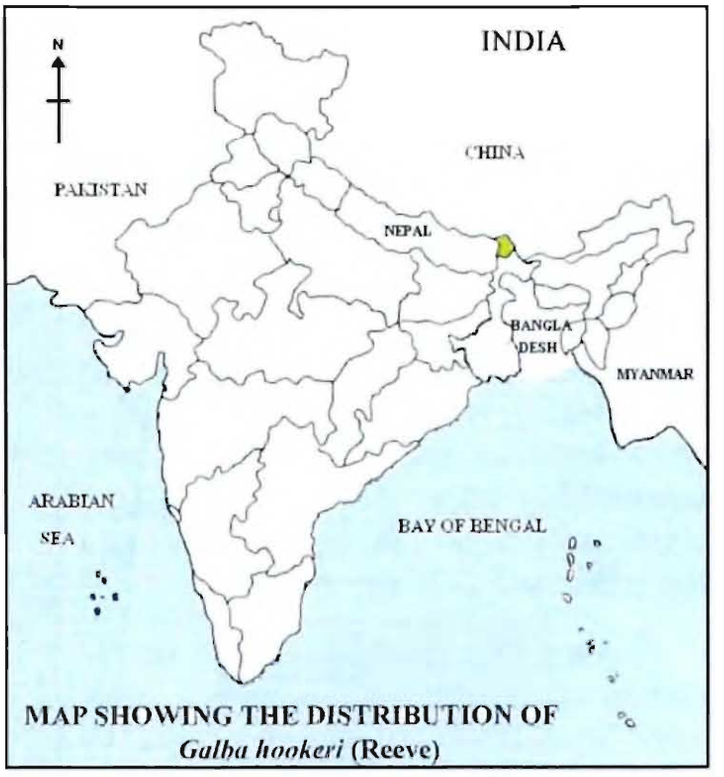
Type location : Natural History Museum, London.

Latest name and Reference : *Lymnaea hookeri* : Dey, Barua and Mitra, 2003, *Fauna of Sikkim, State Fauna Series,* **9**(Part-5), p. 133. *Zool. Surv. India.*

Diagnosis : Shell small, globosely elongate, smooth, upper margin of whorls broadly flattened : spire very short; aperture wide; columellar callous thick, columellar fold broad.

Distribution : India : Sikkim.

Elsewhere : Tibet.



MAP SHOWING THE DISTRIBUTION OF *Galba hookeri* (Reeve)

Galba truncatula (Mueller, 1774)

1774. *Buccinum truncatula* Mueller, *Verm. Terr. Fluv. Hist.*, **2** : 130. Type locality : Denmark.

1925. *Limnaea truncatula* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 161, fig. V 3-5.

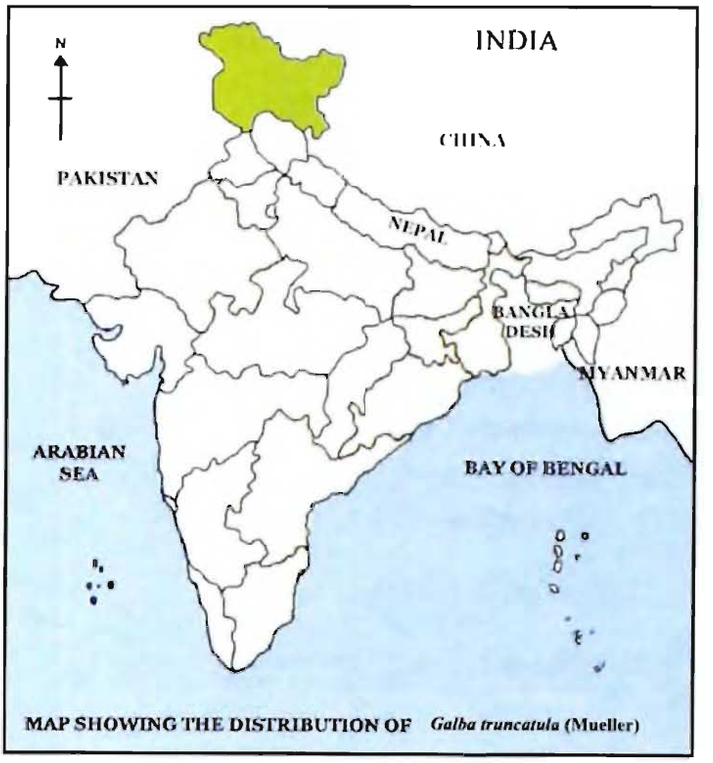
1968. *Lymnaea truncatula* : Rajagopal and Subba Rao, *Proc. Symposium. Mollusca*, pt. 1 : 108

Fig. 159. A. Dorsal view of *Galba truncatula* (Mueller)

Fig. 159. B. Ventral view of *Galba truncatula* (Mueller)

Type location : Not Known.

Latest name and Reference : *Lymnaea truncatula* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 133, fig. 291.



MAP SHOWING THE DISTRIBUTION OF *Galba truncatula* (Mueller)

Diagnosis : Shell smaller in size with strongly impressed sutures; spire as high as aperture; whorls truncate, body whorl not buldging; sculptured with very fine spiral striation; aperture 1/3 rd of shell length; body whorl more than ½ of total length; columellar fold broad and forms a flat projection over the umbilicus.

Remark : Closely allied to *L. andersoniana* but the umbilical pore more prominent and not occluded by columellar fold. Found in small streams, seepages and temporary collections of water in cool and humid places. It serves as a well known intermediate host of *Fasciola hepatica.*

Hubendick (1951) described the detail of genitalia of this species.

Distribution : India : Kashmir (alt. 2730 M to 3365 M), Chitral (9000ft), Chushod (3,213 M), Dras (3,075 M), Kangral (3,365), Spitok (3,253).

Elsewhere : It is mainly a Holarctic species also distributed in South West Arabia, discontinuous distribution in Africa. Cameroon (Hubendick, 1951) is a doubtful locality record.

Genus ***Radix*** Montfort, 1810

1810. *Radix*, Montfort, *Conch. Syst.*, **2** : 266. Type species : *L auricularia* (Linnaeus)

Shell medium, variable in size; spire acuminate, never very long, often very short; body whorl inflated and usually expanded; outer lip more or less broadly flattened; radula with tricuspid laterals; male intromittent organ with the proximal part slender and at least nearly as long as distal part; prostrate subcylindrical or pyriform.

Key to the species

1. Spire scaleriform or canalised at the base; body whorl inflated .....(2)

– Spire not scaleriform or canalised at the base; body whorl not much inflated ....*R.. perista* (Issel)

2. Shell longer; spire short; body whorl very much inflated; columellar fold narrow abruptly below umblicius ..... *R. auricularia* (Linnaeus)

– Shell smaller; body whorl very less inflated; columellar fold not narrow .....(3)

3. Spire extremely short; body whorl greately inflated ..... *R. brevicauda* (Sowerby)

– Spire moderately exserted; body whorl not greately inflated ..... *R. lagotis*

Radix auricularia (Linnaeus, 1758)

1758. *Helix auricularia* Linnaeus, *Syst. Nat.* ***ed.*** **10** : 774. Type locality : Sweden.

1925. *Limnaea auricularia* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 158. fig. I-2, 4.

1968. *Lymnaea auricularia* : Rajagopal and Subba Rao, *Proc. Symposium Mollusca*, pt. 1 : 102.

Fig. 160. A. Dorsal view of *Radix auricularia* (Linnaeus)

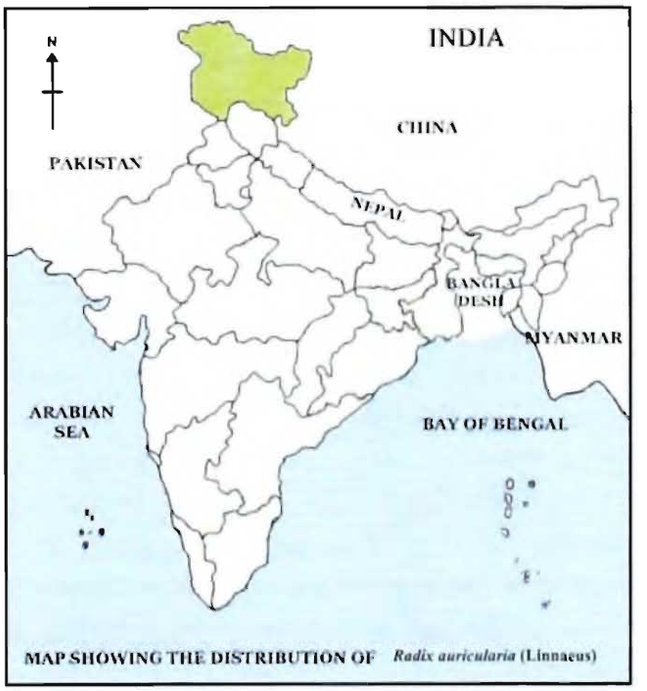
Fig. 160. B. Ventral view of *Radix auricularia* (Linnaeus)

Type location : Not known.

Latest name and Reference : *Lymnaea auricularia* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 134, figs. 300, 301.

Diagnosis : Shell thin, highly fragile, inflated, columella strongly twisted, the fold obliterating the umbilicus. Spire deeply sunken into the body whorl. The colour of the periostracum is light pinkish blue. Generally found in paddy field crawling on the mud.

Orientobilharzia turkestanicum was recorded from this snail.



MAP SHOWING THE DISTRIBUTION OF *Radix auricularia* (Linnaeus)

Distribution : India : Kashmir (Commonly found around Acchabal).

Elsewhere : Europe as far south as Spain, Italy, Northern Asia, Afganisthan

Annandale and Rao (1925), Hubendick (1945) studied the radula. Hubendick (1951) studied the detail of genitalia.

Radix brevicauda (Sowerby, 1873)

1873. *Limnaea brevicauda* Sowerby, in : *Reeve. Conch. Icon.*, **18** : sp. no. 105, pl. 15. Type locality : Kashmir.

1968. *Lymnaea brevicauda* : Rajagopal and Subba Rao, *Proc. Symposium Mollusca*, pt. 1 : 103.

Fig. 161. A. Dorsal view of *Radix brevicauda* (Sowerby)

Fig. 161. B. Ventral view of *Radix brevicauda* (Sowerby)

Type location : Natural History Museum, London.

Latest name and Reference : *Lymnaea brevicauda* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 134, figs. 302, 303.

Diagnosis : The species is characterised by having a thick and hard shell. Spire short and slender; body whorl strongly bulging; columellar fold distinct but not very sharp. Dark brown colour in fresh condition. In living condition the animal including its mantle is of a dull yellow colour. When a crawling snail is lifted up, its mantle can be seen as the animal slowly withdraws inside the shell.

The detail descriptions of genitalia were given by Annandale and Rao (1925) and Hubendick (1951).

Distribution : India : Kashmir

Elsewhere : China.

Radix lagotis f. ***costulata*** (von Martens, 1874)

1874. *Limnaea lagotis* var. *costulata*, Martens, *Fedt. Reise Turken.*, **2** : 26, pl. 2, fig. 24. Type locality : Taschkent.

1878. *Limnaea lagotis* var. *costulata* : Nevill, in Hume's *Sec, Yarkand. Miss. Moll.*, p. 8.

Fig. 162. A. Dorsal view of *Radix lagotis* f. *costulata* (von Martens)

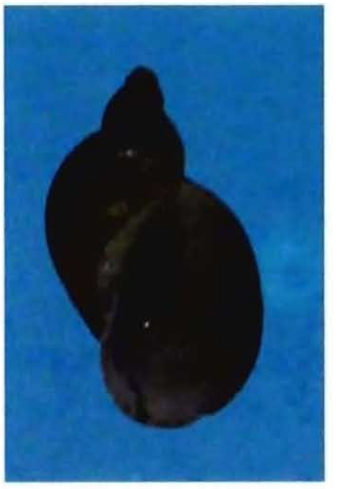


Fig. 162. B. Ventral view of *Radix lagotis* f. *costulata* (von Martens)

Type location : Not known.

Diagnosis : Spire is larger and aperture is less expanded than in *striata*, shape of the aperture being more or less constant.

Distribution : India : Kashmir, Ladakh : Leh

Elsewhere : Asia : Turkestan : Tashkent; Tibet : Chusol (4155 M), Gyantse, Mugleb (4155 M).

f. ***defilippi*** (Issel, 1865)

1865. *Limnaea defilippii*, Issel, *Catalog. Moll. Miss. Ital. in Persia* : 45, pl., iii, figs., 62, 63. Type locality : Lake Goktscha, Armenia.

Fig. 163. A. Dorsal view of *Radix lagotis* f. *defilippi* (Issel)

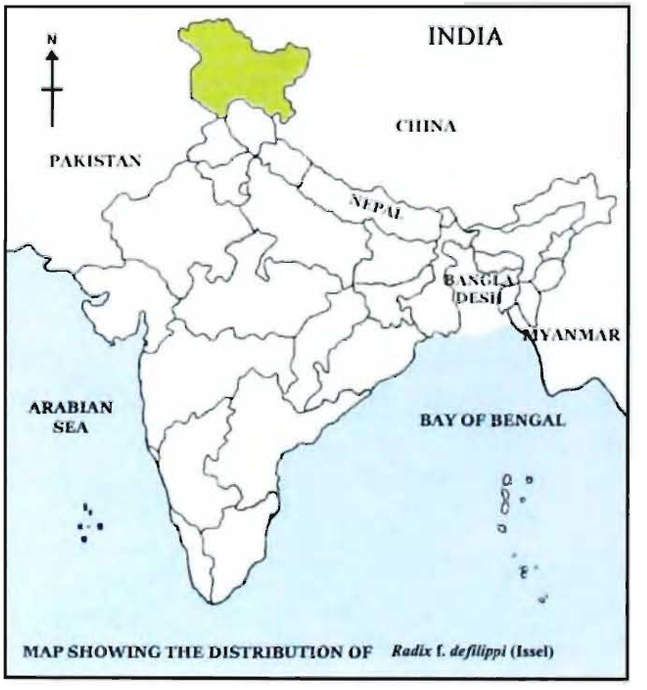
Fig. 163. B. Ventral view of *Radix lagotis* f. *defilippi* (Issel)

Type location : Not known.

Diagnosis : Shell larger, extremely fragile, highly polished with elongated scalariform spire, aperture not much expanded, columellar fold not well developed.

Distribution : India : Kashmir.

Elsewhere : USSR : Armenia : Lake Goktscha



form ***solidissima*** (Kobelt, 1872)

1872. *Limnaea lagotis* var. *solidissima*, Kobelt, *Malak. Blaett.*, **19** : 77, pl. 2, figs. 17, 18. Type locality : Himalaya.

1925. *Lymnaea lagotis* var. *solidissima* : Annandale and Rao, *Rec. Indian Mus.*, **27**, p. 154.

Fig. 164. A. Dorsal view of *Radix lagotis* form *solidissima* **(Kobelt)**

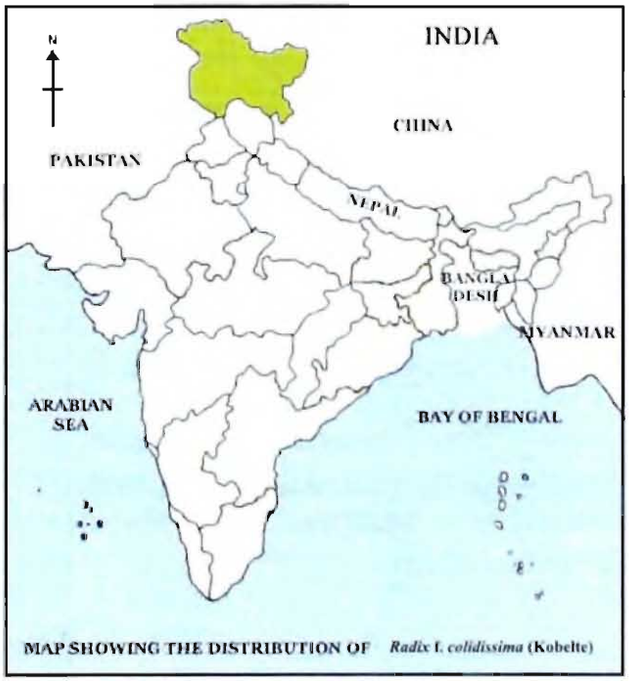
Fig. 164. B. Ventral view of *Radix lagotis* form *solidissima* **(Kobelt)**

Type location : Not known.

Diagnosis : Shell not very large, solid, very thick, extremely variable with a very short spire. Peristome well developed but the columellar fold non-porcellaneous.

Distribution : India : Kashmir.

Elsewhere : Tibet : Chusol (4155M), Tsar Tso (4231M), Panggong Tso (Pankong Lake) (4220M).



form ***striata*** (Andreae, 1911)

1911. *Limnaea lagotis* var. *striata* Andreae in Futterer, *Durch. Asien.*, **3** : 75. Type locality : Central Asia.

Fig. 165. A. Dorsal view of *Radix lagotis* form ***striata*** (Andreae)

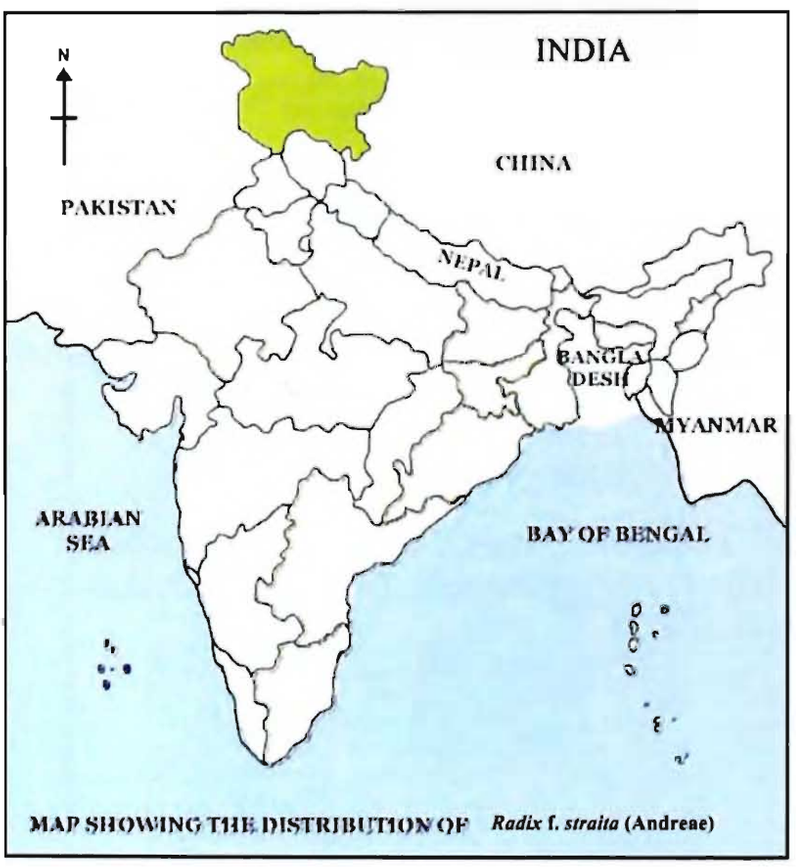
Fig. 165. B. Ventral view of *Radix lagotis* form ***striata*** (Andreae)

Type location : Not known.

Diagnosis : Aperture of the shell is ovoid at the earlier stage of life and becomes semi-circular or auriculate in the adult. Fine longitudinal striae seen in some cases; columellar fold broad and well developed; radula with large teeth but the central is relatively small. Shells from Kashmir are thin and pale horny in colour.

Distribution : India : Kashmir

Elsewhere : Central Asia : Gobi desert : Sulai-ho; Tibet: Gyantse (3980M.), Mangtsa (4398M), Somada (4246).



MAP SHOWING THE DISTRIBUTION OF *Radix l. straita* (Andreae)

Radix persica (Issel, 1865)

1865. *Limnaea auricularia* var. *persica* Issel, *Moll. Miss. Ital. Persca* (Torimo), : 47. Type locality : Iran.

1925. *Limnaea persica* : Annandale and Rao, *Rec. Indian Mus.*, **27** : 151.

1989. *Lymnaea persica* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 133, figs. 304, 305.

Fig. 166. A. Dorsal view of *Radix persica* (Issel)

Fig. 166. B. Ventral view of *Radix persica* (Issel)

Type location : Not known.

Latest name and Reference : *Radix persica* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part 5), p. 207. *Zool. Surv. India*:

Diagnosis : Shell not much large, body whorl inflated, spire short, pointed and slightly oblique, sutures deep, canaliculate, a thin columellar callous present. Outer lip well expanded, extends betyond the body whorl posteriorly; columella distinctly reflected and twisted.

Distribution : India : Andhra Pradesh, Delhi, Himachal Pradesh: Kumaon Lakes, Kangra valley, Renuka; Jammu & Kashmir, Mizoram, Punjab, Uttar Pradersh.

Elsewhere : Europe as far south as Spain and Italy; North Asia; Afganistan.

Genus ***Stagnicola*** Leach in Jeffreys, 1830

1830. *Stagnicola* Leach in Jeffreys, *Linn. Trans.*, **16**(2) : 376. Type species : *Lymnea palustris* Mueller

A cold water genus confined to North America, Northern Europe and Northern Asia. Occurrence of this genus from India (Andhra Pradesh) is rather intriguing.

Stagnicola tungabhadraensis Ray, 1967

1967. *Lymnaea tungabhadraensis* Ray, *J. Conch.* **104**(1) : 4, fig. 1. Type locality : Main canal near Makdona village in the Tungabhadra project area, Kurnool district, Andhra Pradesh.

1989. *Lymnaea (Stagnicola) tungabhadraensis* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 136, figs. 296, 297.

Fig. 167. A. Dorsal view of *Stagnicola tungabhadraensis* Ray

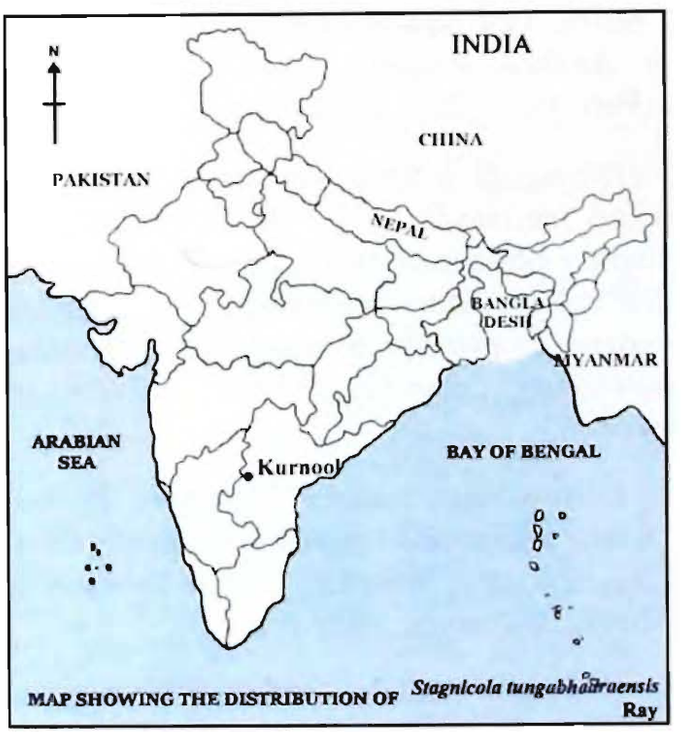
Fig. 167. B. Ventral view of *Stagnicola tungabhadraensis* Ray

Type location : National Zoological Collection, ZSI, Regd. No. M 17602/3 (Holotype).

Latest name and Reference : *Stagnicola tungabhadraensis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 207. *Zool. Surv. India.*

Diagnosis : Shell elongate- turreted, perforate, whorls 6, rounded rapidly increasing in size, body whorl large, a little more than half of total length of columella twisted and strongly reflected over the perforation.

Distribution : India : Andhra Pradersh : Kurnool



Superfamily PHYSOIDEA

Family PHYSIDAE

Shell medium, sinistral, with a sharp pointed spire and smooth surface. Tentacles long and slender. Pseudobranch absent and respiration performed by a long finger like projections of mantle. Copulatory organ with a simple penis; preputium have a large gland externally visible. Radular teeth arranged in transverse and oblique rows. Eggs are deposited irregularly in rounded masses.

Genus ***Physa*** Draparnaud, 1801

1801. *Physa* Draparnaud, *Tab. Moll.* France, **31** : 52. Type species : *Bulla fontinalis* Linnaeus, 1758.

Sinistral shell with pointed spire and an externally visible gland within the preputium.

Externally this genus closely resemblance with *Bullinus*, but it distinguished from it by lack of blood haemoglobin, pseudobranch, the presence of mantle processes and the different copulatory organ.

India, Central and South America, Africa.

Physa acuta Draparnaud, 1805

1805. *Physa acuta* Draparnaud, *Histoire naturelle des mollusques terrestres et fluviatiles de la France, Paris* : 55.(Type locality : River Garonne, France).

1980. *Physa acuta* : Brown, *Freshwater Snails of Africa and their Medical importance*, p. 212, fig. 115a.

Fig. 168. A. Dorsal view of *Physa acuta* Draparnaud

Fig. 168. B. Ventral view of *Physa acuta* Draparnaud

Type location : Not known.

Latest name and Reference : *Physa acuta* : Surya Rao, 1997, *Fauna of Delhi, State Fauna Series,* **6**, p. 121. *Zool. Surv. India,*

Diagnosis : Shell moderate, sinistral, ovate, transparent but thick and sharply pointed apex; spire sharpe and pointed; sutures oblique; body whorl large and around; sculpture smooth; aperture ovate.

Distribution : India : Delhi, Maharashtra.

Elsewhere : North America, introducing in Europe, Africa and South East Asia: Pakistan

MAP SHOWING THE DISTRIBUTION OF *Physa acuta* Draparnaud

Remark : The species prefers polluted water, found commonly in irrigation channels, dams, and streams in or near town and may be well adapted to undergo anhydrobiosis (Brown, 1940). Though this species has only recorded from India (Pune, Maharashtra) by Subba Rao *et al.* (1994); the large numbers of examples collected, suggest its abundant occurrence in river Yamuna at Delhi (Surya Rao *et al.*, 1997).

Superfamily PLANORBOIDEA

Family PLANORBIDAE

Shell small to medium, discoidal or planispiral with a small aperture, apex does not project above the plane. Shell and anatomical features are highly diverse. Foot simple, elongated and tapers into faint posterior. A short and broad fleshy portion present above the anterior region of foot called velum bears head, tentacles and eyes. Tentacles long, filiform, cylindrical and bear eyes on their inner bases. Blood reddish, contains haemoglobin. Radula with bicuspid central tooth, large bi or tricuspidal lateral teeth are long, narrow and multicuspidal marginal teeth.

The respiratory organ, excretory system and genitalia are present on the left side. Respiratory organ mainly a lung supplemented by an extra pulmonary appendage or pseudobranch is situated close to pallial aperture.

Hermaphrodite. Genital and pulmonary aperture situated on the left side. Penial complex variable, always with a preputicum and a verge. Eggs deposited in gelatinous mass attached to aquatic weeds.

Cosmopolitan. Commonly found in shallow waters and littoral regions. A few of them found in large water bodies like lakes, tanks but majority of them confined to small ditches, ponds which get dried up during summer.

Some important contributions of the taxonomy of Planorbids are Germain (1921-23), Annandale (1922) and Rao (1923). Annandale and Prashad (1921) attempted a generic revision of Indian Planorbids. Most of these works were based on shell characters only. Baker (1945) classified the family Planorbidae based on genitalia and other anatomical characters. Hubendick (1955) and Meier Brook (1979) are the significant anatomical works.

Subfamily PLANORBINAE

Shell discoidal or lens shaped with internal septa in some species; whorls distinct, regularly increasing in size, upper and lower side flattened.

Radula with 2 cusps on the central tooth and 3 major cusps on the inner lateral teeth. Pseudobranch consists of a simple lobe sometimes with longitudinal ridges. Excretory and genital opening lies on the left side of the animal. One or more prostatic tubules open either directly on vas deferens or through a separate prostatic duct. Copulatory organ varies but without utrapenis, tip of penis unarmoured, partly sclerotised or with a cuticular style. Spermathecal sac attached to lower part of the uterus by a slender duct. Egg capsule nearly circular in outline, with spirally arranged eggs.

Tribe **Planorbeae**

Key to the genera

1. Shell elongated or ovoid, apex acute, aperture elongated ..... ***Camptoceras*** Benson

– Shell discoidal, apex and whorl in one plane, aperture not elongated .....(2)

2. Whorls widely coiled, last whorl proportionately large, all whorls viewed ventrally, aperture oval or oblique .....(3)

– Whorls narrowly coiled, last whorl large, embracing a greater part of the preceding whorl, only last whorl viewed ventrally, aperture heart shaped .....(4)

3. Shell depressed, carinate or subcarinate at the periphery, 3-4 rapidly increasing whorls ..... ***Gyraulus*** Charpentier

– Shell less depressed, usually rounded at periphery, whorls more than 4 .... *Planorbis* Geoffroy

4. Shell without internal septa ..... ***Hippeutis*** Charpentier

– Shell with internal septa ..... ***Segmentina*** Fleming

Genus ***Planorbis*** Geoffroy, 1767

1767. *Planorbis* Geoffroy, *Traite Coq. Paris,* : 12. Type species : *Helix planorbis* Linnaeus by tautonomy (Baker, 1945).

Shell upto 20 mm, discoidal, whorls bluntly angular or carinate; aperture small, rounded or oval; right margin of aperture projecting beyond the left. Radula long and narrow; cusps with thin teeth. Penis sheath slender and short; Penis lacking either selerotisation or stylet.

Throughout Europe, North and West Asia and Northern Africa.

This genus represented by two species from India (Kashmir only). No parasites were recorded from any of these species.

Planorbis planorbis tangitarensis Germain, 1918

1918. *Planorbis (Tropidiscus) planorbis* var. *tangitarensis* Germain, *Bull. Mus. Hist. nat. Paris,* **24**(4) : 267. Type locality : North Tangitar.

1968. *Planorbis planorbis* var. *tangitarensis* : Rajagopal and Subba Rao, *Proc. symposium on Mollusca.,* pt. 1, : 109.

Type location : MNHN.

Fig. 169. A. Dorsal view of *Physa acuta* Draparnaud

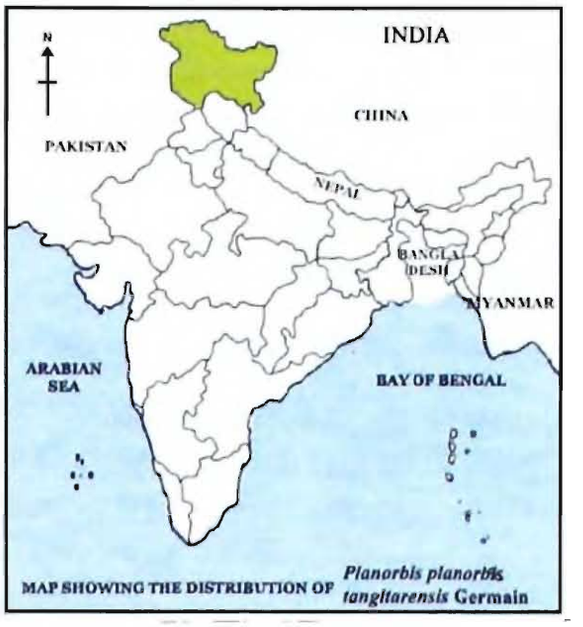
Fig. 169. B. Ventral view of *Physa acuta* Draparnaud

Latest name and Reference : *Planorbis planorbis tangitarensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 152, figs. 353-355.

Diagnosis : Shell flattened, compressed and angulation not very distinct, spire showing distinctly all five whorls, aperture more contracted than typical form, the under side less deeply sunk.

Distribution : India : Kashmir.

Elsewhere : Asia : North Tangitar.



Planorbis rotundatus Poiret, 1801

1801. *Planorbis rotundatus* Poiret, *Coq. Ausne environs de Paris, Prodrome*, p. 93. (non *Planorbis rotundatus* Brongniart).

1968. *Planorbis rotundatus* : Rajagopal and Subba Rao, *Proc. Symposium on Mollusca*, pt. 1 : 109, p. 1.1, figs. 2-4.

Type location : MNHN.

Fig. 170. A. Dorsal view of *Planorbis rotundatus* Poiret

Fig. 170. B. Ventral view of *Planorbis rotundatus* Poiret

Latest name and Reference : *Planorbis rotundatus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 152, figs. 356-358.

Diagnosis : Shell thick, rounded; whorls 5, gradually increasing, rounded without any angulation; aperture oval.

Distribution : India : Kashmir.

Elsewhere : Siberia; Europe : Norway; Sweden; Spain; Portugal; Africa; Algeria; Morocco; Tunisia.

Genus *Gyraulus* Charpentier, 1837

1837. *Gyraulus* (Agassiz MS) Charpentier, *Neue Denkschr. Allg. Schweiz Gesell.*, **1**(2) : 21. Type species : *Planorbis albus* Mueller, 1776=*Planorbis hispidus* Draparnaud, Subsequent designation Dall, 1870.

Shell small (upto 7 mm) in diameter, disc like, thin, greatly depressed, with flatly rounded whorls, angular or carinate, 3 to 5 increasing rapidly, pale translucent or transparent, with or without hair like projections of the periostracum; peripheral keel present or absent; body whorl with slightly deflected aperture; aperture oblique, lip simple.

Radula with bicuspid central tooth, lateral tri or bicuspid and several with sharp cusps on marginal. Pseudobranch with a lamella on its dorsal surface (Brown, 1965); Penis with a sub terminal opening and a dagger like stylet.

World wide. Commonly occurs in ponds, ditches, drains etc. Usually found attached to leaves and root of aquatic vegetations. Eggs deposited in numbers in a gelatinous mass, attached to the weeds or other substrates submerged in water.

Key to the species

1. Whorls $3^1/_2$ ..... (4)

– Whorls 4 or more ..... (2)

2. Shell acutely keeled at periphery, body whorl slightly deviating from spirals of upper whorls ..... *G. euphraticus* (Mousson)

– Shell rounded or subangulate at periphery, body whorl not deviating from spirals of upper whorls ..... (3)

3. Body whorl subangulate or rounded, suture impressed, umbilicus wide, aperture ovate-lunate ..... *G. convexiusculus* (Hutton)

– Body whorl rounded not angular but slightly compressed in the middle towards the extremity, suture deep, umbilicus less wide, aperture obliquely ovate ..... *G. ladacensis* Nevill

4. Last whorl distinctly wide and descending infront of aperture .....(5)

– Last whorl not much wide and not descending infront of aperture .....(7)

5. Body whorl with remarkable departure from the axis of previous whorls, aperture oblique, heart shaped, whitish rib within the aperture ..... *G. labiatus* (Benson)

– Body whorl very large, without remarkable departure from the axis of previous whorl, aperture very oblique, no whitish rib within the aperture .....(6)

6. Body whorl convex above and below neither carinate nor angular, deeply umbilicated ..... *G. pankongensis* (von Martens)

– Body whorl very large and well dilated at the extremity, not deeply umbilicate ..... *G. saltensis* Germain

7. Aperture very oblique, sculpture with fine longitudinal striae ..... *G. barrackporensis* (Clessin)

– Aperture ovate-lunate, sculpture with longitudinal striae sometimes so strong to be called subcostae ..... *G. rotula* (Benson)

Gyraulus barrackporensis (Clessin, 1886)

1886. *Planorbis barrackporensis* Clessin, *Limnaeiden*: in Martini and Chemnitz's, *Syst. Conch. Cab.*, p. 125, pl. 18, fig. 2. Type locality : Barrackpore.

1886. *Planorbis huttoni* : Clessin, *Limnaeiden*, In : Martini and Chemnitz's, *Syst. Conch. Cab.*, p. 139, pl. 18, fig. 4.

1922. *Gyraulus barrackporensis* : Prashad, *Rec. Indian Mus.*, **24** : 15.

Fig. 171. A. Dorsal view of *Gyraulus barrackporensis* (Clessin)

Fig. 171. B. Ventral view of *Gyraulus barrackporensis* (Clessin)

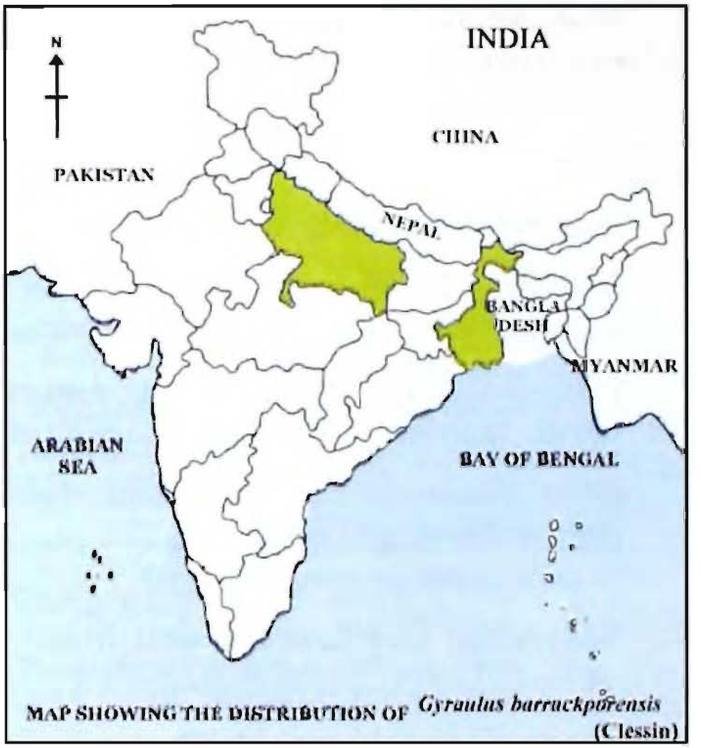
Type location : Berlin Museum, Berlin

Latest name and Reference : *Gyraulus barrackporensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 153.

Diagnosis : Whorls rapidly increasing, body whorl more rounded and more dilated at its extremity, aperture very oblique, shell thin, shining yellowish brown, fragile, subtransparent, sculptured with fine longitudinal striae.

Distribution : India : Uttar Pradesh : Varanasi; West Bengal : Kolkata, Hugli, 24-Paraganas (North).

Elsewhere : Tibet.



Gyraulus convexiusculus (Hutton, 1849)

1849. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc. Beng.*, **18**(2) : 657. Type locality : Afganisthan.

1864. *Planorbis saigonensis* : Crosse et Fischer *J. Conchyl.*, **11** : 362, pl. 13, fig. 7. Type locality : Saigon.

Fig. 172. A. Dorsal view of *Gyraulus convexiusculus* (Hutton)

Fig. 172. B. Ventral view of *Gyraulus convexiusculus* (Hutton)

Fig. 173. A. External view of *Gyraulus convexiusculus* (Hutton)

Fig. 173. B. Internal view of *Gyraulus convexiusculus* (Hutton)

1867. *Planorbis compressus* : von Martens in Weber, *Zool. Ergebn. Niederl. Ost. India,* **4** : 13, pl. 1, figs. 17-22, pl. 12, figs. 7-10. Type locality : Java.

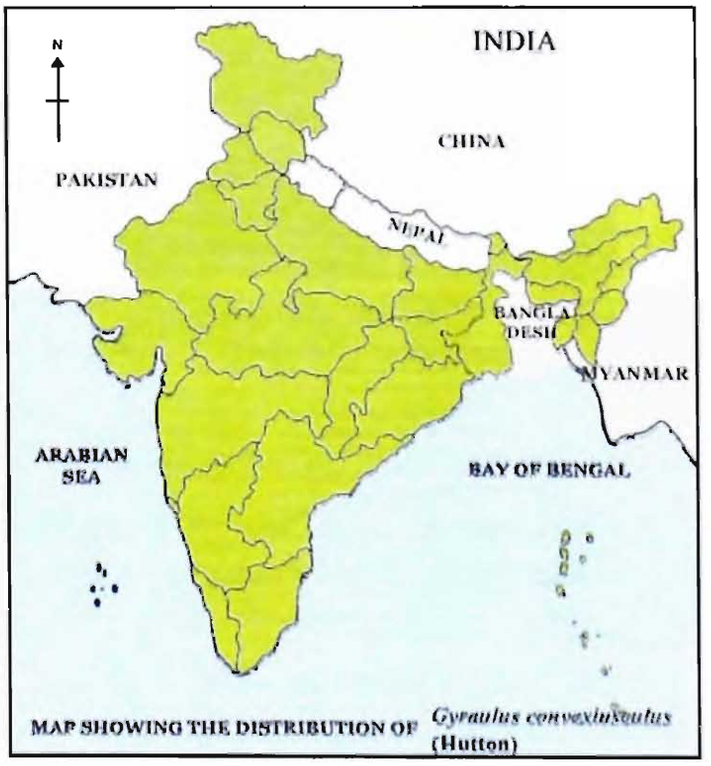
1885. *Planorbis demissus* : Westerlund, *Ur. Vega. Expeditionens Vetenskaplig Jakattagelser,* **4** : 204, pl. 4, fig. 16. Type locality : Point de Galle, Ceylon.

1956. *Gyraulus convexiusculus* : Benthem Jutting, *Treubia,* **23**(2) : 463.

1989. *Gyraulus convexiusculus* : Subba Rao, *Handbook of Freshwater Molluscs of India* : 154, figs. 362-364.

Type location : Not known.

Latest name and Reference : *Gyraulus convexiusculus* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, Zool. Surv. India*: *State Fauna Series*, **5**(Part 5), p. 209.



MAP SHOWING THE DISTRIBUTION OF *Gyraulus convexiusculus* (Hutton)

Diagnosis : Shell small, discoidal, with 4-5 depressed whorls, not more than 5mm in diameter, umbilicus wide, transparent, periphery subangulate, closely and obliquely striatulate aperture ovate, lunate.

Radula with well developed central teeth with sharply pointed cusps, inner lateral teeth with two stout, sharply pointed cusps, outer teeth with three cusps and marginal teeth with 4-6 slender cusps.

Bali and Dutt (1978) studied the life cycle of this species.

Remarks : A very common species occurring in lakes, ditches, ponds & rice fields. Larval forms of *Cercaria chugathi, C. furgolensis, C. gyraulusi, C. rithorensis, Giganticotyla crumnifer, G. explanatum* and *Fasciola elongatus* were recorded.

Distribution : India : Common throughout.

Elsewhere : Iran to Philippines and Japan.

Gyraulus euphraticus (Mousson, 1874)

1874. *Planorbis euphraticus* Mousson, *J. Conchyl.*, **22** : 44. Type locality : "La- Basse- Mesopotomie."

1834. *Planorbis compressus* : Hutton (nec. Michaud), *J. Asiat. Soc. Beng.*, **(2) 3** : 93.

1919. *Gyraulus euphraticus* : Annandale and Prashad, *Rec. Indian Mus.*, **18** : 54, figs. 7A, 8A.

1989. *Gyraulus euphraticus* : Subba Rao, *Handbook of Freshwater Molluscs of India* : 155, figs. 365-367.

Fig. 174. A. Dorsal view of *Gyraulus euphraticus* (Mousson)

Fig. 174. B. Ventral view of *Gyraulus euphraticus* (Mousson)

Type location : Zoologischer Museum, Zurich.

Latest name and Reference : *Gyraulus euphraticus* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 84. *Zool. Surv. India.*

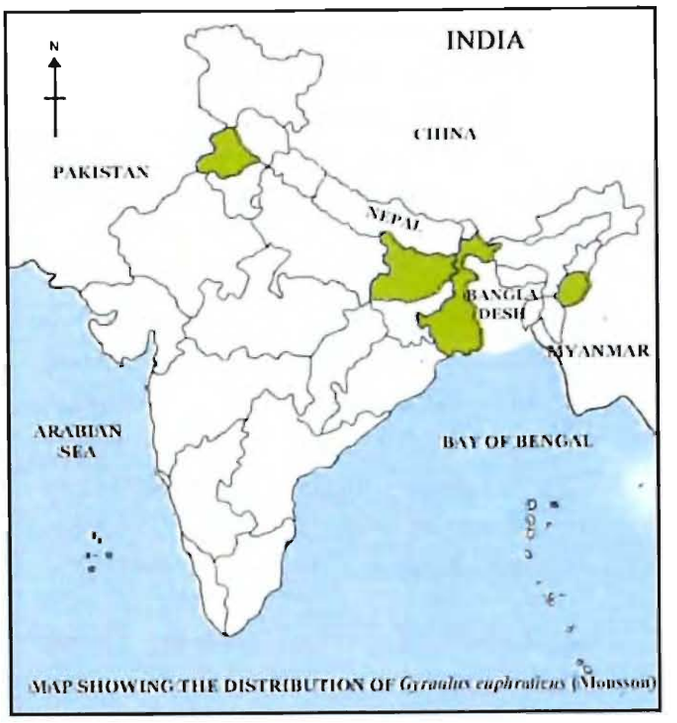
Diagnosis : Shell resembles *Gyraulus convexiusculus,* but differs in more compressed body strongly carinate, more opaque, sculptured coarsely and irregularly, body whorl deviates from spiral whorl.

Distribution : India : Bihar, Manipur : Thoubal, Bishenpur, Chandel; Jharkhand, Punjab, West Bengal.

Elsewhere : Baluchistan; Afganisthan.

Remarks : A Palaearctic species. Larval forms of *Echinostoma ilocanum*, a parasite of rat and man and *Diplodiscus amphicrus* were recorded from this snail.

Annandale and Prasad (1919) discused the affinities of this species.



Gyraulus labiatus (Benson, 1850)

1850. *Planorbis labiatus* Benson, *Ann. Mag. nat. Hist.*, **(2)5** : 350. Type locality : "In stagne prope urbem, Moradabad."

1915. *Planorbis (Gyraulus) labiatus* : Preston, *Fauna Brit India*, Mollusca (Freshwater Gastropoda & Pelecypoda), p. 119, fig. 5.

1925. *Gyraulus labiatus* : Annandale, *Rec. Indian Mus.*, **27** : 109.

1989. *Gyraulus labiatus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 155, figs. 342-344.

Type location : Natural History Mueum, London.

Latest name and Reference : *Gyraulus labiatus* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 210. *Zool. Surv. India.*

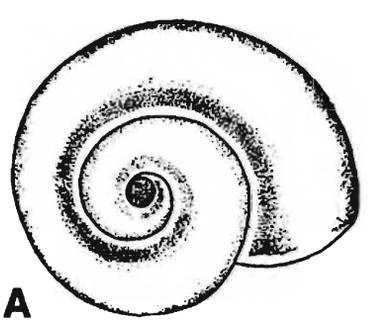


Fig. 175. A. Dorsal view of ***Gyraulus lablatus*** (Benson)

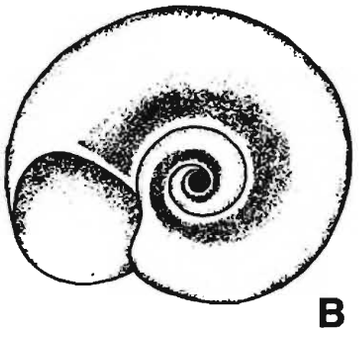


Fig. 175. B. Ventral view of ***Gyraulus labiatus*** (Benson)

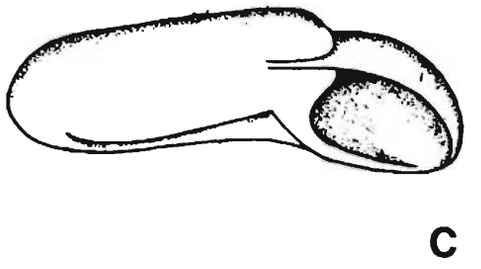
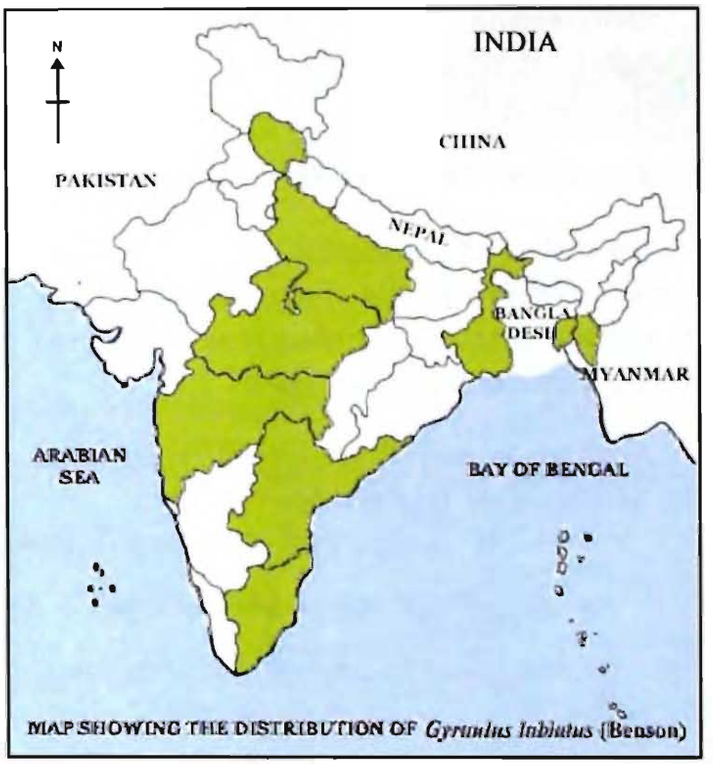


Fig. 175. C. Lateral view of ***Gyraulus labiatus*** (Benson)

Diagnosis : Shell depressed with $3^1/_2$ whorls, obliquely striate, aperture oblique and a little descending in front, body whorl with remarkable deviation from main axis, a whitish rib present within the aperture.



MAP SHOWING THE DISTRIBUTION OF *Gyraulus laevis* (Benson)

Distribution : India : Andhra Pradesh: Annantapur, Cuddapah, Kurnool, Rangareddy; Himachal Pradesh, Madhya Pradesh, Maharashtra: Khandala; Mizoram, Tamil Nadu: Mettupalayam; Tripura (West & North), Uttar Pradesh, West Bengal: Kolkata, Haora, Birbhum.

Elsewhere : Myanmar: He- Ho Gorge and Shan States.

Remarks : It closely agrees with *Gyraulus convexiusculus*, but has less number of whorls and a conspicuous ridge in inner surface of the lip.

Gyraulus ladacensis Nevill, 1878

1878. *Planorbis (Gyraulus) laevis* var. *ladacensis* Nevill, *Scientific Results Second Yarkand Mission* : 10. Type locality : Ladakh.

1937. *Gyraulus ladacensis* : Prashad, *Rec. Indian Mus.*, **39** : 273.

Fig. 176. A. Dorsal view of *Gyraulus ladacensis* Nevill

Fig. 176. B. Ventral view of *Gyraulus ladacensis* Nevill

Type location : National Zoological Collection, ZSI, Regd. No. M 17822/3 (Syntype)

Latest name and Reference : *Gyraulus ladacensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 156, figs. 359-361.

Diagnosis : Shell depressed, solid, almost flat above and below with oblique longitudinal striae, whorls 4½, convex, with a slope, sutures deep, body whorl rounded, slightly compressed in the middle towards extremity, a little dilated, quite widely and less oblique, ovate, transverse, upper margin reaching beyond the columellar margin.

MAP SHOWING THE DISTRIBUTION OF *Gyraulus ladacensis* Nevill

Distribution : India : Ladakh.

Elsewhere : Tibet

Gyraulus pankongensis (von Martens, 1882)

1882. *Planorbis pankongensis* von Martens, *Mem. Acad. Imp. Sci. St.Petersbourg*, (7) **30**(11) : 45, pl. 4, figs., 14a-c.Type locality : Lake Pankong, Tibet.

1968. *Gyraulus pankongensis* : Rajagopal and Subba Rao, *Proc. Symposium on Mollusca*, pt. 1 : 111, fig., 1.

Fig. 177. A. Dorsal view of *Gyraulus pankongensis* (von Martens)

Fig. 177. B. Ventral view of *Gyraulus pankongensis* (von Martens)

Type location : Not known.

Latest name and Reference : *Gyraulus pankongensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 156, figs. 368-370.

Diagnosis : Shell solid, with oblique longitudinal striae, subconvex above, with narrow central margin; whorls 3-3½, convex, rapidly increasing; sutures deep, body whorl very large, deeply umbilicate, convex above and below, neither carinate nor angular, well dilated, sometimes more or less descending at the extremity; aperture oblique, round with convergent and approaching margins united by a wide callosity, peristome interiorly bordered with white thickening; white or yellowish,.

Distribution : India : Kashmir.

Elsewhere : Central Asia : China; Tibet.

Gyraulus rotula (Benson, 1850)

1850. *Planorbis rotula* Benson, *Ann. Mag. Nat. Hist.*, **5** : 351. Type locality : Moradabad, Uttar Pradersh.

1885. *Planorbis (Gyraulus) liratus* : Westerlund, *Ur. Vega. Expeditionens Vetenskapliga Jakattagelser*, **4** : 206, pl. 4, fig. 18. Type locality : Point de Galle, Ceylon.

1915. *Planorbis (Gyraulus) rotula* : Preston, *Fauna Brit. India*, Mollusca (Freshwater Gastropoda and Pelecypoda), p. 122.

Fig. 178. A. Dorsal view of *Gyraulus rotula* (Benson)

Fig. 178. B. Ventral view of *Gyraulus rotula* (Benson)

Type location : Natural History Museum, London.

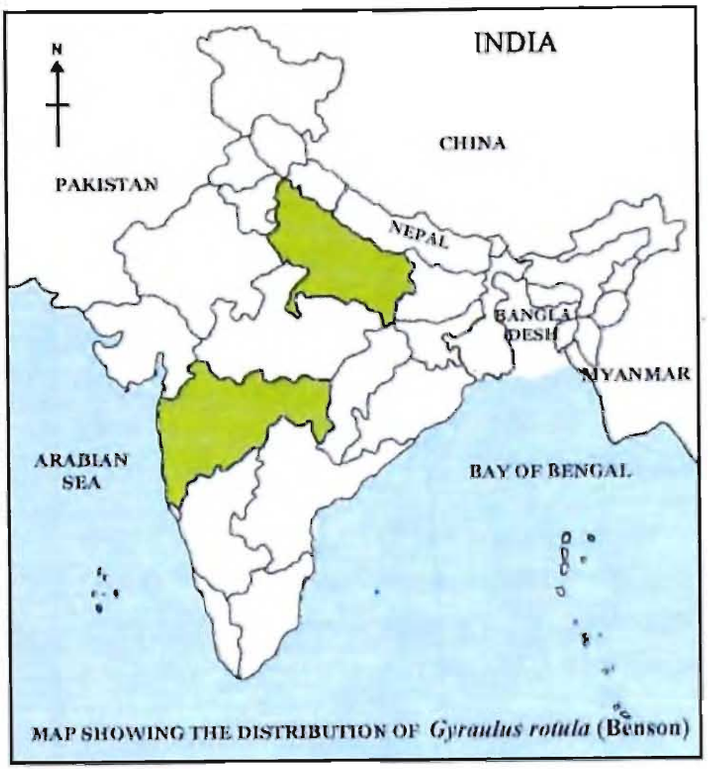
Latest name and Reference : *Gyraulus rotula* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 157, fig. 328.

Diagnosis : Shell small, thin, greatly depressed; periostracum thin, brightly, sometimes lightly tinted greenish; whorls 3½, obsolete spiral striations; sutures impressed; sculpture with longitudinal striae, sometimes strong, subcostae.

Shell resembles with *G. convexiusculus* but differs from it in having less number of whorls and rounded body whorl.

Distribution : India : Maharashtra, Uttar Pradesh.

Elsewhere : Sri Lanka; Thailand.



MAP SHOWING THE DISTRIBUTION OF *Gyraulus rotula* (Benson)

Gyraulus saltensis Germain, 1922

1922. *Planorbis (Gyraulus) saltensis* Germain, *Rec. Indian Mus.*, **21** : 127. Type locality : Salt Range, Punjab (Subfossil)

Fig. 179. A. Dorsal view of *Gyraulus saltensis* Germain

Fig. 179. B. Ventral view of *Gyraulus saltensis* Germain

Type location : MNHN.

Latest name and Reference : *Gyraulus saltensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 157.

Diagnosis : Shell depressed, convex above and subconvex below; whorls 3½, rapidly increasing, first one small and deeply sunk; body whorl large and well dilated at the extremity; aperture very oblique.

Germain (1922) described this species and expressed the doubt regarding its validity which needs more materials for study.

Distribution : Known from type locality only.

Tribe **Camptocerateae**

Genus ***Camptoceras*** Benson, 1843

1843. *Camptoceras* Benson. *Calcutta J. Nat. Hist.*, **3** : 465. Type species : *Camptoceras terebra* Benson, 1843

Shell elongate or ovoid, sinistral, apex acute; whorls 3 to 4, angular or subangular and externally oblique; sutures deep and broad; aperture elongate, less than length of spire. Foot short, not projecting beyond the aperture.

Externally the animal resembles with *Gyraulus*, but distinguished from it by having a large anal siphon and absence of penial stylet or flagellum.

Found crawling on weeds in deep pool of river beds. It secrets an epiphragm during unfavourable conditions (Annandale and Prashad 1918).

Discontinuous distribution. Found in India, Japan, Myanmar, Siberia and Thailand. Annandale and Prashad (1918, 1920) discussed in detail the habits and taxonomy of the genus. No parasite was recorded.

Key to the species

1. Shell elongated, atleast 3 times as long as broad, sculpture without strong spiral lines ..... *C. terebra* Benson

– Shell irregularly ovate, less than 3 times as long as broad, sculpture with strong spiral lines ..... (2)

2. Shell more than 5 mm long, whorls 4, suture with much less well defined and not so angular at the margin ..... *C. subspinosum* Annandale and Prashad

– Shell less than 5 mm long, whorls $2^{1}/_{2}$, suture with well defined and angulate at its margin ..... *C. lineatum* Blanford

Camptoceras lineatum Blanford, 1871

1871. *Camptoceras lineatum* Blanford, *J. Asiat. Soc. Beng.*, **40** : 40, pl. 11, fig. 3. Type locality : Nazirpur, Shushong, Mymensingh Dist., Bangladesh.

1914. *Camptoceras lineatum* : Gude, *Fauna Brit. India Mollusca*, **2** : 464, fig. 144.

1921. *Camptoceras lineatum* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 586.

Fig. 180. A. Dorsal view of ***Camptoceras lineatum*** Blanford

Fig. 180. B. Ventral view of ***Camptoceras lineatum*** Blanford

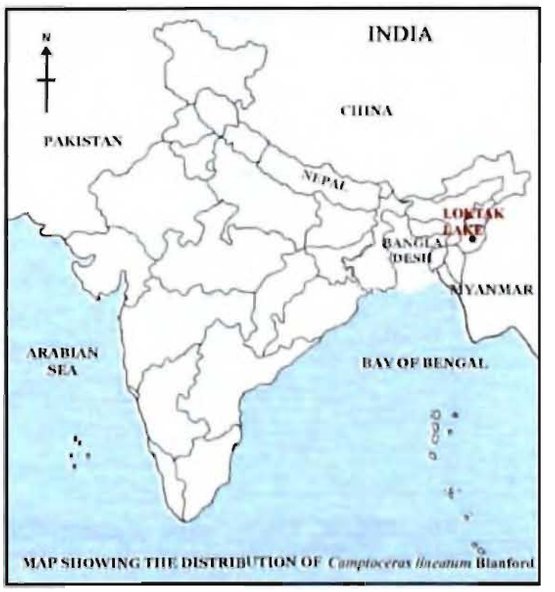
Type location : Natural History Museum, London.

Latest name and Reference : *Camptoceras lineatum* : Subba. Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 145, figs. 322, 323.

Diagnosis : Whorls contiguous except behind the peristome, aperture oval and sub oblique.

Distribution : India : Manipur : Loktak Lake.

Elsewhere : Bangladesh, Mymensing.



Camptoceras subspinosum Annandale and Prashad, 1920

1920. *Camptoceras subspinosum* Annandale and Prashad, *J. Proc. Asiat. Soc. Beng.*, (N.S.) **16** : 28, fig. 1. Type locality : Between Khanabal and Islamabad, Kashmir (alt. 4000-5000 ft).

Type location : National Zoological Collection, ZSI Regd. No. M 11671/2 (Paratype, lost).

Latest name and Reference : *Camptoceras subspinosum* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 145.

Diagnosis : Shell sculptured with subspinose spiral lines.

Distribution : India : Kashmir

Camptoceras terebra Benson, 1843

1843. *Camptoceras terebra* Benson, *Calcutta J. Nat. Hist.*, **3** : 465. Type locality : Ram Ganga, at Moradabad, Uttar Pradesh.

1855. *Camptoceras terebra* : Benson, *Ann. Mag. nat. Hist.*, **(2)15** : 10.

1918. *Camptoceras terebra* : Annandale and Prashad, *J. Proc. Asiat. Soc. Beng.*, (N.S.) **14** : 457, pl. 12, figs. 1, 1a (Paratype).

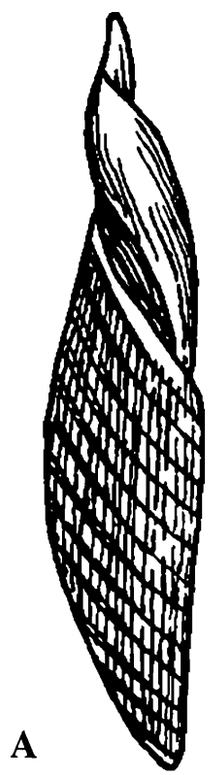


Fig. 181. A. Dorsal view of ***Camptoceras terebra*** Benson

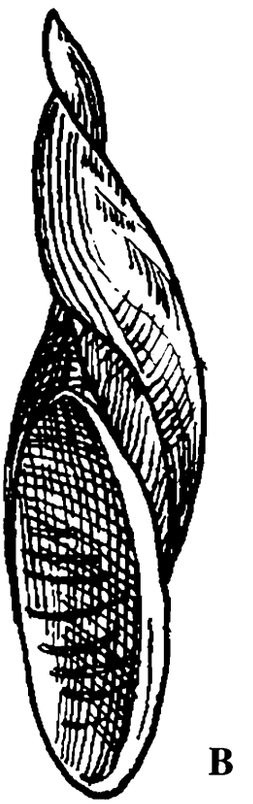


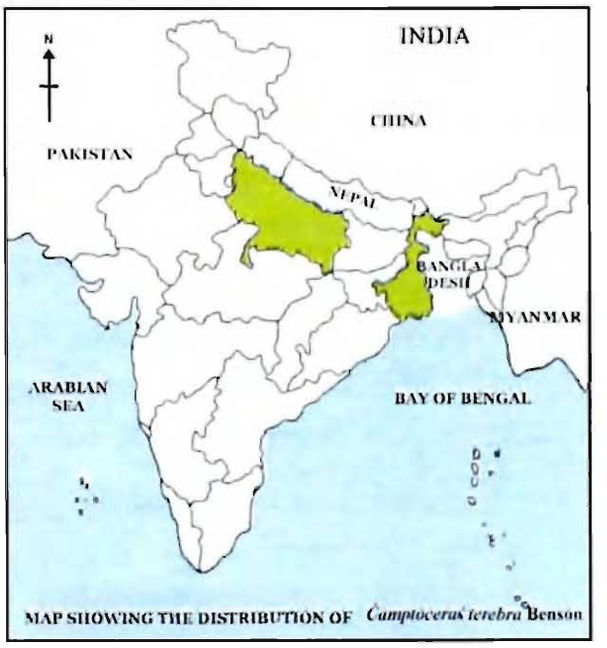
Fig. 181. B. Ventral view of ***Camptoceras terebra*** Benson

Type location : National Zoological Collection, ZSI (Paratype lost)

Latest name and Reference : *Camptoceras terebra* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 144, figs. 320, 321.

Diagnosis : A rare species, characterised by elongate elliptical shell and vertical aperture with flattened inner upper margin.

Distribution- India : Uttar Pradesh, West Bengal : Mogra (Hugli Dist.).



MAP SHOWING THE DISTRIBUTION OF *Camptoceras terebra* Benson

Tribe **Segmentinineae**

Genus ***Segmentina*** Fleming, 1817

1817. *Segmentina* Fleming, *Edinburgh Encyclopaedia Conchylogy*, ed. 7, vol. 12. Type species : *Nautilus lacustris* Lightfoot= *Planorbis nitidula* Mueller

Shell small, thin, glossy, convex above and flattened below; body whorl large, carinate or angulate;internally divided by white tranverse lamellae; aperture sub trigonal.

North Africa, Europe and Asia.

Represented by a subgenus and three species from India.

Subgenus ***Polypylis*** Pilsbry, 1906

1906. *Polypylis* Pilsbry, *Pro. Acad. Sci. Philad.*, **58** : 166. Type species : *Segmentina largillierti* Dunker = *S. hemisphaerula* Benson.

Shell less compressed, not carinate, parietal laminae; obliquely transverse, others transverse, basal long, a shorter one in the outer wall, wide space in between lamellae. Preputium without penial gland.

India, Eastern China, Myanmar.

Key to the species

1. Shell conoidal, whorls 4 or more ..... (2)

   Shell trochoid, whorls $3^{1}/^{2}$ ..... *S. (P.) trochoidea* (Benson)

2. Shell more pronouncedly conoidal, whorls gradually increasing in size, side of the keel forming a small angle ..... *S. (P.) taia* Annandale and Prashad

– Shell less pronouncedly conoidal, whorls not gradually increasing in size, side of the keel not forming an angle..... *S. (P.) calatha* (Benson)

Segmentina (Polypylis) calatha (Benson, 1850)

1850. *Planorbis calathus* Benson, *Ann. Mag. nat. Hist.*, (2)5 : 348. Type locality : Moradabad, Uttar Pradesh.

1923. *Segmentina calatha* Germain, *Rec. Indian Mus.*, 21 : 168.

1817. *Segmentina (Polypylis) calatha* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 150, figs., 339-341.

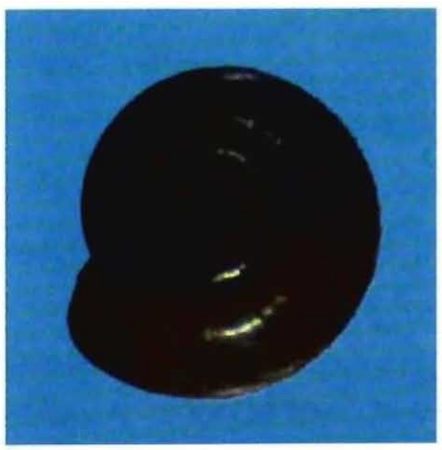


Fig. 182. A. Dorsal view of *Segmentina (Polypylis) calatha* (Benson)

Fig. 182. B. Ventral view of *Segmentina (Polyhylis) calatha* (Benson)

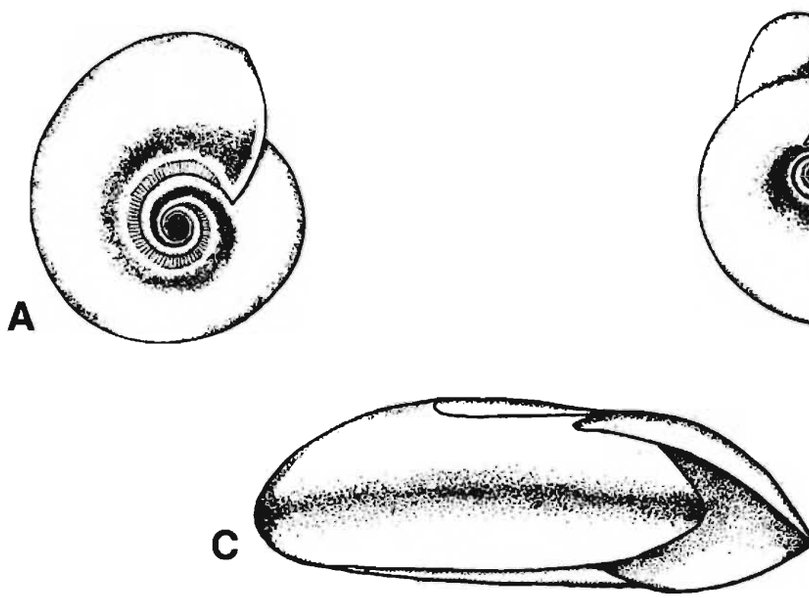


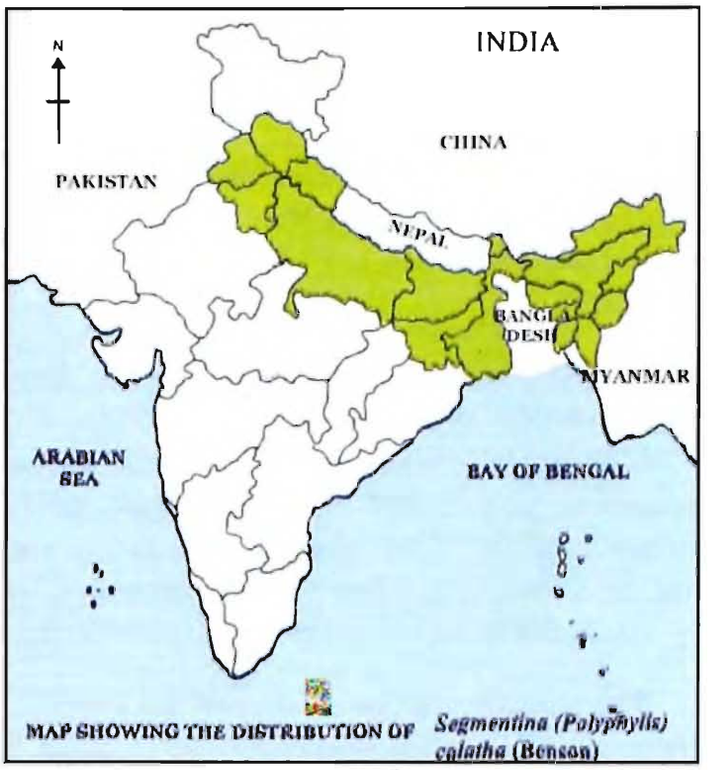
Fig. 183. A. Dorsal; **B.** Ventral; **C.** Lateral view of ***Segmentina (Polypylis) calatha*** (Benson)

Shell small, thin, glossy, convex above and flattened below; body whorl large, carinate or angulate;internally divided by white tranverse lamellae; aperture sub trigonal.

Type location : Natural History Museum, London.

Latest name and Reference : *Segmentina (Polypylis) calatha* : Mookherjee, Thakur, Mitra and Barua, 2000. *Fauna of Tripura, State Fauna Series,* **7**, p. 336. *Zool. Surv India.*

Diagnosis : Shell small, thin, glossy, whorls four, body whorl angular, sutures impressed, aperture subtriangular, parietal laminae obliquely transverse, lamellae wide space. Vergic sac with two flagella.



Distribution : Widely distributed in northern India, Tripura.

Elsewhere : Myanmar and Sri Lanka.

Segmentina (Polypylis) taia Annandale and Rao, 1925

1925. *Segmentina taia* Annandale and Rao, *Rec. Indian Mus.*, **27** : 110. fig. 2. Type locality : Inle Lake, Burma.

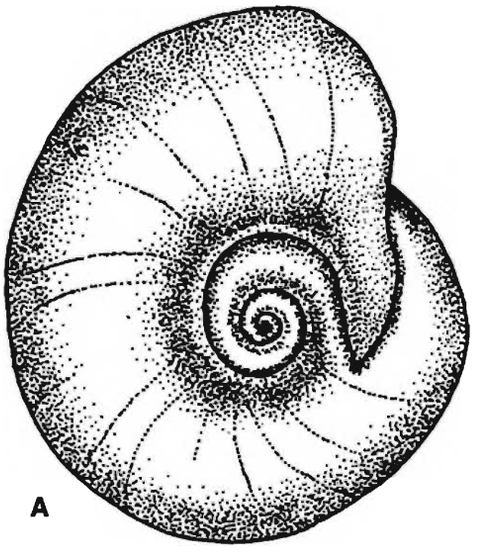


Fig. 184. A. Dorsal view of ***Segmentina (Polypylis) taia*** Annandale and Rao (Syntype)

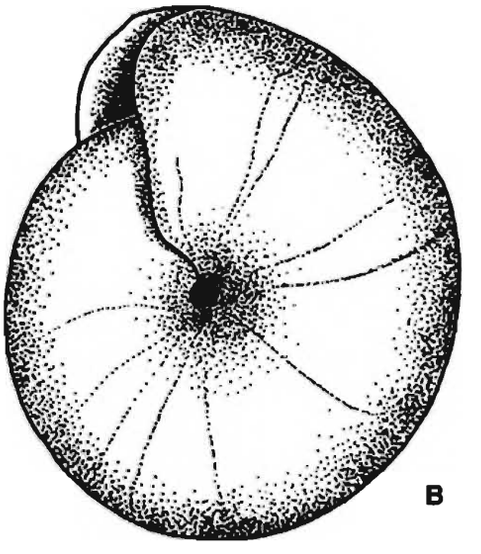
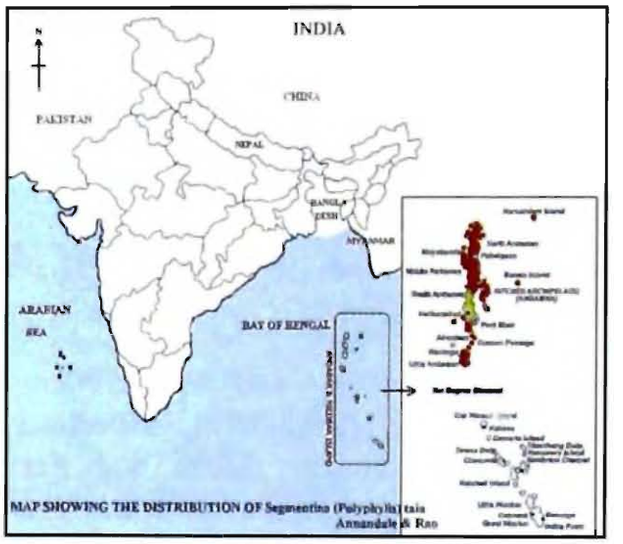


Fig. 184. B. Ventral view of ***Segmentina (Polypylis) taia*** Annandale and Rao (Syntype)

Type location : National Zoological Collection, ZSI, Regd No. M 12461/2 (Holotype)



Latest name and Reference : *Segmentina (Polypylis) taia* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 150.figs. 349, 350.

Diagnosis : Shell conoidal, flattened below and concave above, whorls 4½, body whorl with abrupt slope towards the ventral surface, umbilicus minute and as a shallow pit, internal ridges visible from below in adult shell, aperture quadrate when viewed ventrally, ventral margin of peristome almost straight meeting the strongly arched and convex dorsal margin; yellowish-brown.

This species can be distinguished from *S. calathus* by its more pronounced conoidal form, whorls gradually increasing, sides of the keel angled, straight ventral margin and greatly arched dorsal margin.

Distribution : India : Andamans : Port-Blair

Elsewhere : Myanmar: Inle Lake, Yawnghwe, South Shan States.

Segmentina (Polypylis) trochoidea (Benson, 1836)

1836. *Planorbis trochoideus* Benson, *J. Asiat. Soc. Beng.*, **5** : 742. Type locality : Barrackpore, near Calcutta.

1923. *Segmentina trochoidea* : Germain, *Rec. Indian Mus.*, **21** : 175.

1945. *Trochorbis trochoideus* : Baker, *The Molluscan Family Planorbidae*, p. 108.

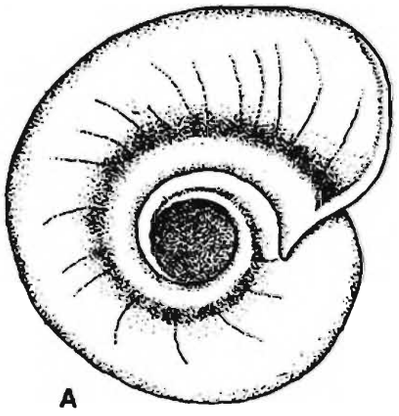


Fig. 185. A. Dorsal view of ***Segmentina (Polypylis) trochoidea*** (Benson)

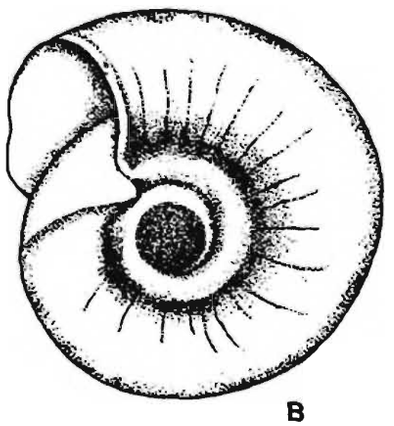


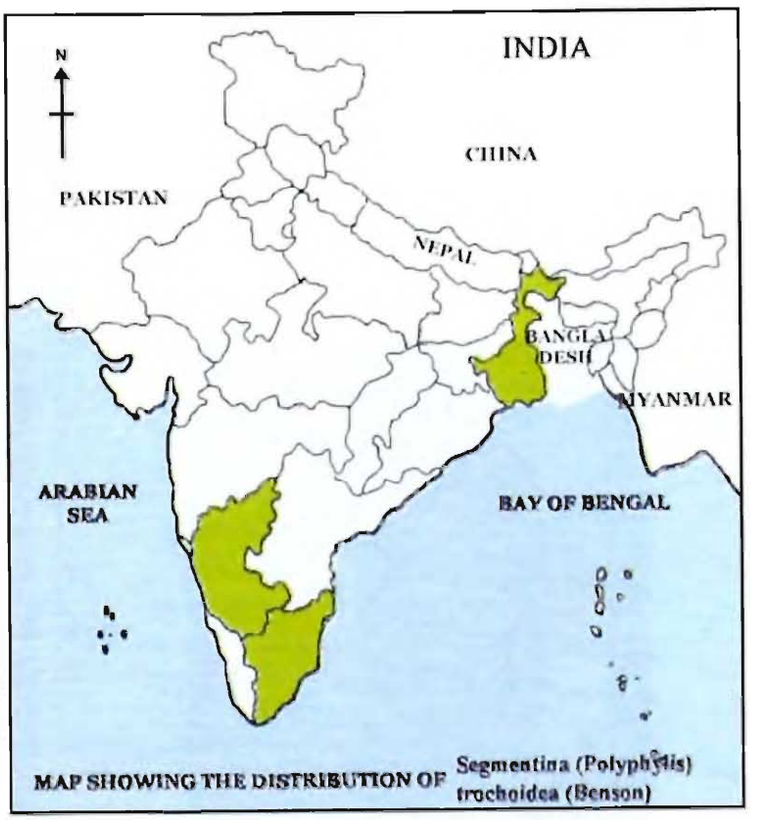
Fig. 185. B. Ventral view of ***Segmentina (Polypylis) trochoidea*** (Benson)

Type location : Natural History Museum, London.

Latest name and Reference : *Segmentina (Polypylis) trochoidea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 150, figs. 347, 348.

Diagnosis : Shell small, trochoid, much smaller than *S. calatha*, whorls 3½, periphery more acute, umbilicus small or totally absent, apertural lamellae weak.

Distribution : India : Karnataka: Belgaon; Tamil Nadu : Chennai; West Bengal : Kolkata, North and South 24-Paraganas.



Elsewhere : Sri Lanka: Balapiti; Myanmar: Inle Lake.

Remarks : *Fasciolopsis buski* was reported from this snail from Assam.

Genus ***Hippeutis*** Agassiz in Charpentier, 1837

1837. *Hippeutis* (Agassix) in Charpentier, Neue. Denkschr. Allg. Schweiz Gessell., 1(2) : Type species : *Helix fontana* Lightfoot, 1767 = *Helix complanata* Linnaeus,1958.

Shell small, discoidal, similar with *Segmentina* but without the internal lamellae. Hermaphrodite with preputial appendages.

Europe, South East Asia, China, Taiwan, Philippines and Japan.

Key to the species

1. Shell with carinate periphery, angularity close to the middle .... *H. fontanus* (Lightfoot)

– Shell with less carinate periphery, angularity close to or at the base .... *H. (H.) umbilicalis umbilicalis* (Benson)

Subgenus ***Hippeutis s. st.***

Hippeutis fontanus (Lightfoot, 1786)

1786. *Helix fontana* Lightfoot, *Phil. Trans.*, **26**(1) : 165, pl., 2, fig. 1. Type locality : Europe.

1968. *Hippeutis fontanus* : Rajagopal and Subba Rao, *Proc. Symposium Mollusca*, pt. 1 : 112, pl. 1, figs. 5-7.

Fig. 186. A. Dorsal view of *Hippeutis fontanus* (Lightfoot)

Fig. 186. B. Ventral view of *Hippeutis fontanus* (Lightfoot)

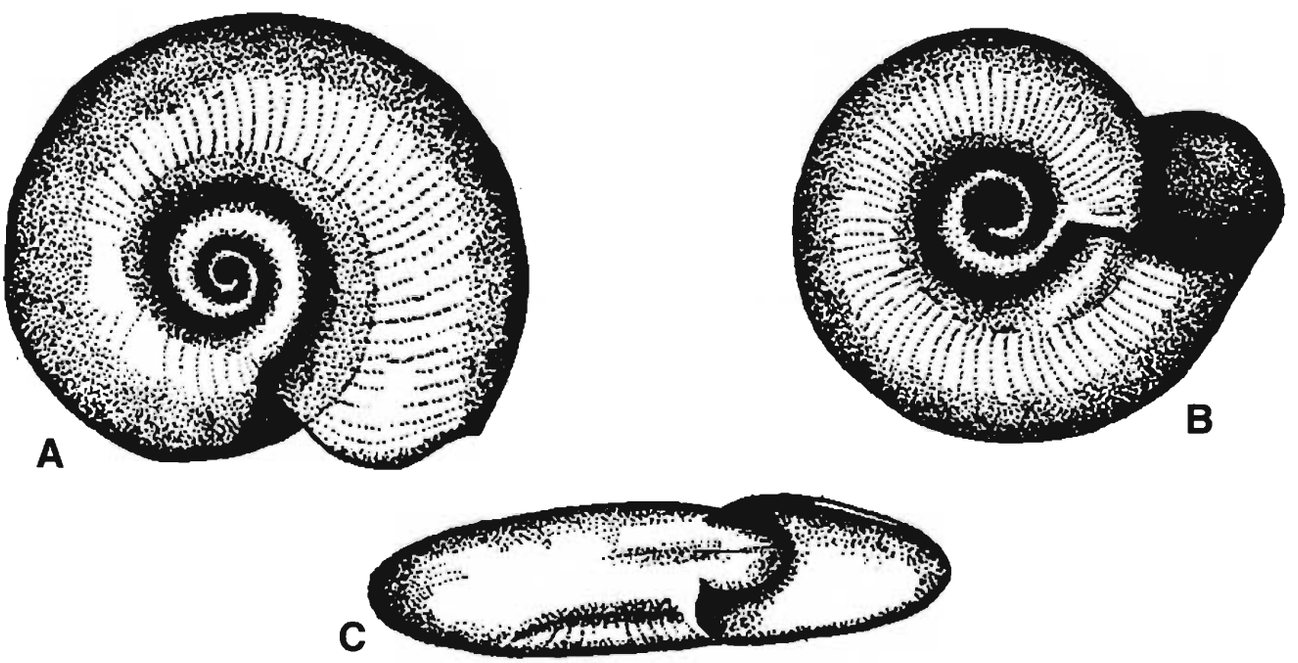


Fig. 187. A. Dorsal view of ***Hippeutis (Hippeutis) fontanus*** (Lightfoot)
Fig. 187. B. Ventral view of ***Hippeutis (Hippeutis) fontanus*** (Lightfoot)
Fig. 187. C. Lateral view of ***Hippeutis (Hippeutis) fontanus*** (Lightfoot)

Type location : Not known.

Latest name and Reference : *Hippeutis (Hippeutis) fontanus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India,* p. 147, figs. 336-338.

Diagnosis : Shell small, lenticular, much depressed, paucispiral; whorls very rapidly increasing, carinate; aperture obliquely heart shaped.

Distribution : India : Kashmir.

Elsewhere : Europe; Asia; Europe : Transcaucasia; West Siberia; Yarkand; England; France; South Spain; Portugal; Norway; Sweden; Finland; Switzerland; Italy; Albania.

Subgenus ***Helicorbis*** Benson, 1855

1858. *Helicorbis* Benson, *J. Asiat. Soc. Beng.*, **24**(2) : 126.

Shell lenticular with less carinate periphery, angularity close at base. Penis without stylet, verge sac with a long flagella and duct connecting the proximal part of the preputium with acessory appendages (Pace,1973).

EIndia, Myanmar, Central and Eastern China, Indonesia, Philippines.

Hippeutis (Helicorbis) umbilicalis umbilicalis (Benson, 1836)

1836. *Planorbis umbilicalis* Benson, *J. Asiat. Soc. Beng.*, **5** : 741. Type locality : Sylhet, Bangladesh.

Fig. 188. A. Dorsal view of *Hippeutis (Helicorbis) umbilicalis umbilicalis* (Benson)

Fig. 188. B. Ventral view of *Hippeutis (Helicorbis) umbilicalis umbilicalis* (Benson)

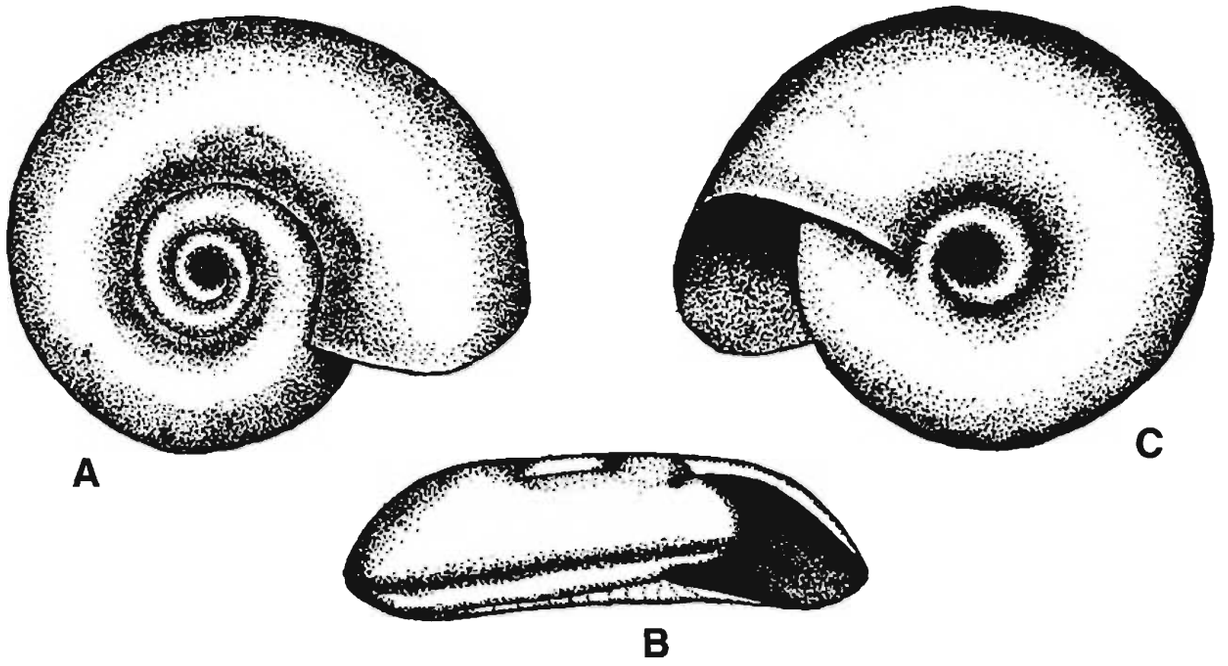


Fig. 189. A. Dorsal view of ***Hippeutis (Helicorbis) umbilicalis*** (Benson)
Fig. 189. B. Ventral view of ***Hippeutis (H.) umbilicalis umbilicalis*** (Benson)
Fig. 189. C. Lateral view of ***Hippeutis (H.) umbilicalis umbilicalis*** (Benson)

1850. *Planorbis caenosus* : Benson, *Ann. Mag. Nat. Hist.*, **(2)5** : 349. Type locality : Moradabad, Uttar Pradesh.

1923. *Segmentina umbilicalis* : Germain, *Rec. Indian Mus.*, **21** : 176, pl. 11, figs. 19-21.

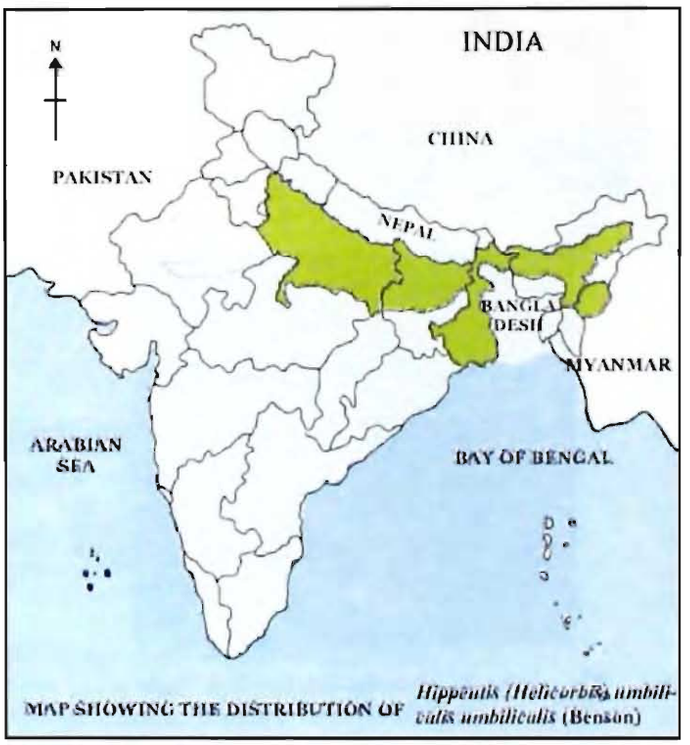
1956. *Helicorbis caenosus* : Benthem Jutting, *Treubia*, **23**(2) : 479, fig. 134.

1989. *Hippeutis (Helicorbis) umbilicalis umbilicalis* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 148, figs. 333-335.

Type location : Not known.

Latest name and Reference : *Hippeutis (Helicorbis) umbilicalis umbilicalis* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 85. *Zool. Surv. India.*

Diagnosis : Shell depressed, small, narrowly coiled, umbilicate, whorls 3, very rapidly increasing in width, body whorl being abruptly wide, round, convex above, flattened below, bluntly angulate at the periphery, aperture heart shaped.



Distribution : India : Assam, Bihar, Manipur, Uttar Pradesh : Kumaon lakes; West Bengal. In the Manipur valley it is most abundant occuring in the Loktak Lake and in Ponds and Swamps admist dense vegetation (Annandale, 1922).

Elsewhere : Myanmar; Indonesia South East Asia; Southern China; Taiwan and the Philippines.

Remarks : It is an intermediate host of *Fasciolopsis buski*. Kumar *et al.* (1968) recorded *Cercaria helicorbis* from this snail.

Family BULLINIDAE

Shell small to medium (upto 35 mm diameter), sinistial, either with spire or discoid. Pseudobranch large, deeply folded and highly vascularised. Radula with two cusps on the central tooth, and three major cusps on the inner lateral teeth. Penis with a long and coiled eversible tube (ultrapenis) attached at both upper and lower end. Prostatic lobes numerous concentrated into compact organ. Spermathecal sac attached to the lower part of the uterus be a slender duct. Egg capsules circular outline, with spirally arranged eggs.

Subfamily BULLININAE

Genus ***Indoplanorbis*** Annandale and Prashad, 1921

1921. *Indoplanorbis* Annandale and Prashad, *Rec. Indian Mus.*, **22**(4) : 578. Type species : *Planorbis exustus* Deshayes

Shell sinistral, discoidal, thick, medium in size; suture deeply impressed; aperture ear shaped.

Foot relatively broad, leaf shaped with broadly rounded anterior and pointed at the posterior; branchial process lobed; genital aperture slit like penis simple, long, cylindrical tube, penial stylet absent.

Monotypic genus, found in southern Asia, south east Arabia and Socotra Island. Common in ponds, ditches and canals with or without vegetations.

Indoplanorbis exustus (Deshayes, 1834)

1834. *Planorbis exustus* Deshayes in Belanger, *voy. Indes-Orientales* : 417, pl. 1. figs. 11-13. Type locality : Malabar Coast.

1956. *Indoplanorbis exustus* : Benthem Jutting, *Treubia*, **23**(2) : 471.

1989. *Indoplanorbis exustus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 142, figs., 326, 327.

Fig. 190. A. Dorsal view of *Indoplanorbis exustus* (Deshayes)

Fig. 190. B. Ventral view of *Indoplanorbis exustus* (Deshayes)

Type location : Not known.

Latest name and Reference : *Indoplanorbis exustus* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 208. *Zool. Surv. India.*

Diagnosis : Shell large, thick, discoidal, sinistral, rounded at periphery, aperture ear-shaped, suture deeply impressed.

Distribution : India : Widely distributed.

Elsewhere : Bangladesh, Iran, Pakistan, Persia, Sri Lanka, Myanmar, Malaya, Indo-China, Tibet, Thailand, Vietnam, Sumatra, Java, Celebes.

Remarks : It serves as intermediate host for a number of trematodes found in goat, sheep, horse, dog, camel, buffaloes and other catles. A large number of cercariae (about 57 types) were recorded from this snail. The important parasites are *Cotylophorun bhaleraoi, C. cotylophorom, C. indica, C. mathurapurensis, Enterohaemotrema plaeorticum, Fasciola gigantica, Gastrodiscus secundus, Gastrothylax crumenifer, Paramphistomum explanatum, P. mehrai, Petagifer srivastavi, Plasmiorchis orientalis, Schistosoma indicum, S. nasalis,* and *S. spindalis.*

Family ANCYLIDAE

Shell small, usually less than 10 mm, cap like, patelliform or shield shaped with obtuse or hooked apex. Aperture large, animal completely covered by the shell. Foot broad and oval, tentacles short, blunt and cylindrical, bearing eyes on the inner bases. Pseudobranch many and present on the left side. Hermaphrodite. Penial stylet or flagellum open into vergic sac. Genital and anal opening on the left.

World wide distribution. Found attached to vegetation in smaller ponds, ditches or on the other debris in smaller rivers of moderate flows and streams. Absent in torrential streams.

Represented by a single genus *Ferrisa* Walker from India.

Subfamily FERRISSINAE

Genus ***Ferrissia*** Walker, 1903

1903. *Ferrissia* Walker, *Nautilus*, **17** : 15. Type species : *Ancylus regularis* Say, 1817.

Small limpet like upto 5 mm, with very fine radial ridges on apex, which is obtuse but never hooked. Copulatory organ with a flagellum; penial stylet on the vergic sac. Aphalic individuals fragnent. Eggs laid on stones or aquatic plants.

Worldwide distribution. Found commonly on vegetation including stagnant seasonal pools, irrigation channels that regularly dry out. A small septum formed in association with aestivation through dry period (Brown, 1980).

Annandale and Prashad (1921) revised the Indian species and placed them under genus *Ancylus*, but based on anatomical studies Burch (1965) and Hubendick (1964) regognised as a genus.

Key to the species

1. Shell more than 5 mm long, apex sharply pointed, very little reflected ..... *F. ceylanica* (Benson)

– Shell less than 5 mm long, apex blunt, reflected to the right .....(2)

2. Outline of the shell biterally asymmetrical; maximum breath in the middle region.. ..... *F. verruca* (Benson)

– Outline of the shell biterally symmetrical; maximum breath in the posterior region .....(3)

3. Side of the shell not parallel; height less than 1/3rd of the length ..... *F. baconi* (Bourguignat)

– Side of the shell parallel; height more than 1/3rd of the length ..... (4)

4. Sculpture with minute radiating striae, deep violet internally .... *F. viola* (Annandale and Prashad)

– Sculpture smooth, dull yellowish internally ..... *F. tenuis* (Bourguignat)

Ferrissia baconi (Bourguignat, 1853)

1853. *Ancylus baconi* Bourguignat, *J. Conchyl. Paris,* **4** : 181. Type locality : Cetle espece habitele Bengale.

1921. *Ancylis (Ferrissia) baconi* : Annandale and Prashad, *Rec. Indian Mus.,* **22** : 592.

Type location : MNHN.

Latest name and Reference : *Ferrissia baconi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India,* p. 138.

Diagnosis : Shell small, thin, outline almost bilaterally symmetrical; side not parallel. Height less than 1/3rd of the length; breadth maximum in the posterior part. Apex blunt reflected to the right.

Distribution : India : Orissa, West Bengal.

Elsewhere : Myanmar: He Ho Gorge; Philippines.

Ferrissia ceylanica (Benson, 1864)

1864. *Ancylus ceylanicus* Benson, *Ann. Mag. nat. Hist.,* **(3)13** : 139. Type locality : Ceylon.

1874. *Ancylus ceylanicus* : Hanley and Theobald, *Conch. Indica,* pl. 81, figs. 1-4.

1921. *Ancylus (Ferrissia) ceylanicus* : Annandale and Prashad, *Rec. Indian Mus.,* **22** : 591.

Type location : Not known.

Latest name and Reference : *Ferrissia ceylanica* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India,* p. 138.

Diagnosis : Shell thin, small, more than 5 mm long, outline bilaterally asymmetrical, maximum breadth at the middle; apex sharply pointed and very little reflected.

Distribution : India : Manipur: Imphal.

Elsewhere : Sri Lanka.

Ferrissia tenuis (Bourguignat, 1862)

1862. *Ancylus tenuis* Bourguignat, *Spicil. Malac.* **1862** : 208. Type locality : Nilgiris.

1921. *Ancylus (Ferrissia) tenuis* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 592.

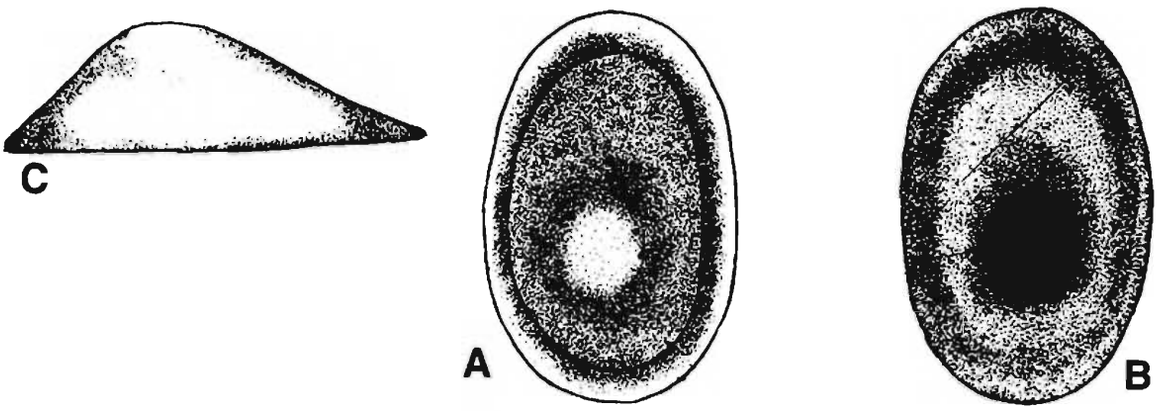


Fig. 191. A. Dorsal view of ***Farrissia tenuis*** (Bourguignat)
Fig. 191. B. Ventral view of ***Farrissia tenuis*** (Bourguignat)
Fig. 191. C. Lateral view of ***Farrissia tenuis*** (Bourguignat)

Type location : MNHN.

Latest name and Reference : *Ferrissia tenuis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 138. figs. 314, 316.

Diagnosis : Shell minute, thin, opaque, fragile, bilaterally symmetrical, greatest breadth on the posterior part; apex blunt reflected right; sculpture smooth without distinct microscopic structure, aperture oblong; brown or blackish externally, dull yellow internally.

Attached to stones, pebbles or floating objects in rivers streams with moderate flow. Breeds in the month of January. Eggs are laid singly on decaying leaves etc in a gelatinous mass.

Considered as intermediate host of human blood fluke, *Schistosoma haematobium* reported from the Gimvi village of Ratnagiri district of Maharashtra. Gadgil and Shah (1955) reported successful infecting of *F. tenuis* in the laboratory and observed cercarial emission in large numbers.

Distribution : India: South India, Nilgiri Hills, Maharashtra.

Ferrissia verruca (Benson, 1855)

1855. *Ancylus verruca* Benson, *Ann. Mag. nat. Hist.*, **(2)15** : 12. Type locality : Bhimtal Kemaonsem in palude prope, Moradabad, nivo Rajhera.

1876. *Ancylus verruca* : Hanley and Theobald, *Conch. Indica* : pl. 81, figs. 2, 3.

1921. *Ancylus (Ferrissia) verruca* : Annandale and Prashad, *Rec. Indian Mus.*, **22** : 589, fig. 18B.

1989. *Ferrissia verruca* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 139, figs. 311, 313.

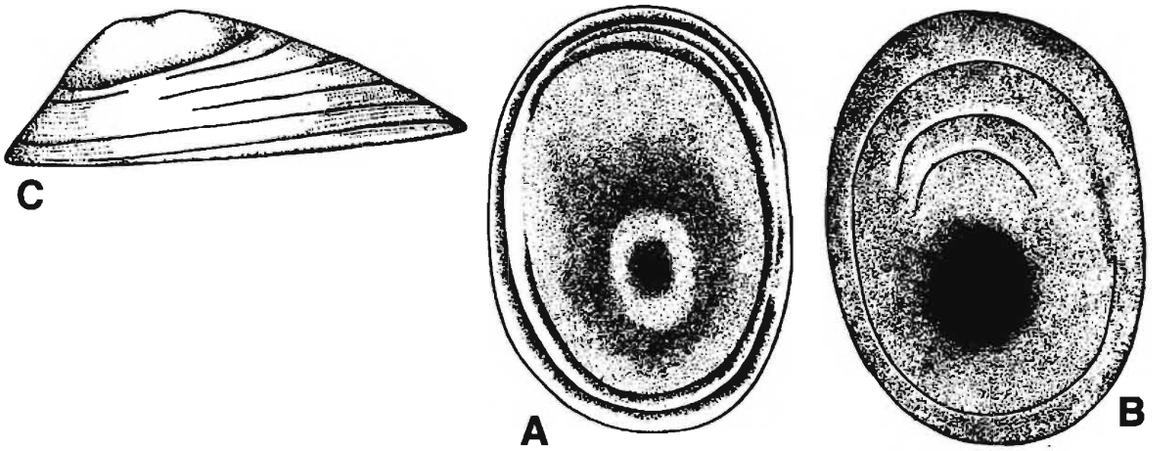


Fig. 192. A. Lateral view of ***Farrissia verruca*** (Benson)
Fig. 192. B. Dorsal view of ***Farrissia verruca*** (Benson)
Fig. 192. C. Ventral view of ***Farrissia verruca*** (Benson)

Type location : Not known.

Latest name and Reference : *Ferrissia verruca* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 83. *Zool. Surv. India.*

Diagnosis : Shell suboval, small, thin, length twice than breadth, greatest breadth near the middle. Outline asymmetrical bilateral. Apex blunt, not elevated, reflected to the right. Blackish in colour.

Found on floating stems, water plants and leaves in pond. Uncommon.

Distribution : Throughout India.

Elsewhere : Sri Lanka but sporadic (Annandale and Prashad, 1921)

Ferrissia viola Annandale and Prashad, 1921

1921. *Ancylus (Ferrissia) viola* Annandale and Prashad, *Rec. Indian Mus.*, **22** : 589, fig. 18A, 19. Type locality : Loktak Lake, Manipur.

1989. *Ferrissia viola* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 139, figs. 317, 319.

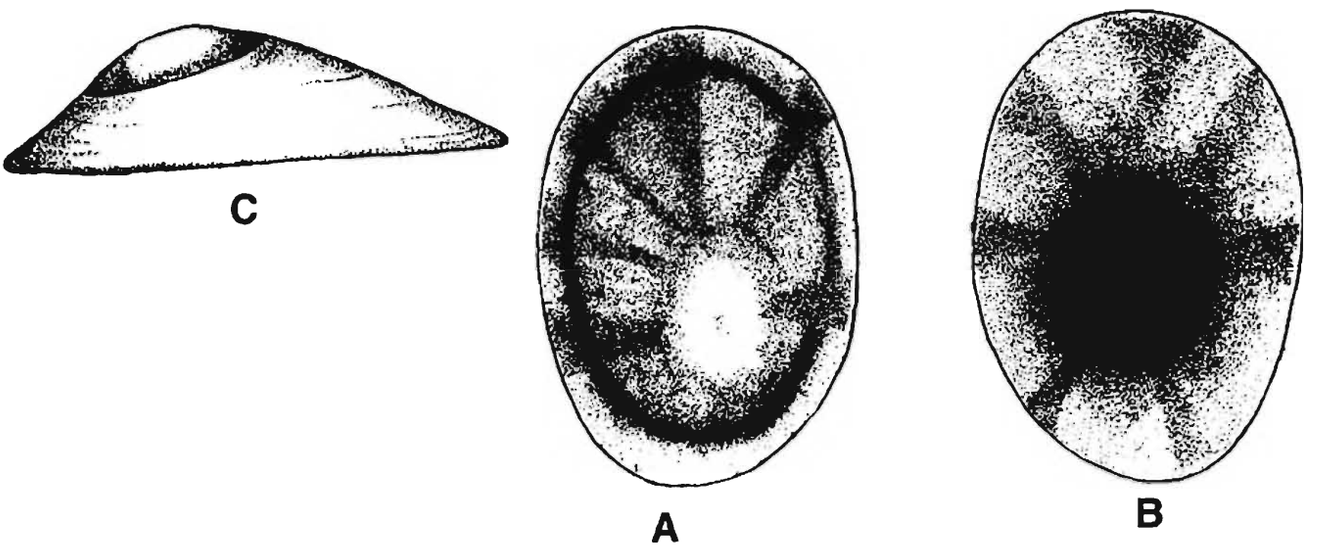


Fig. 193. A. Dorsal view of ***Farrissia viola*** Annandale and Prashad
Fig. 193. B. Ventral view of ***Farrissia viola*** Annandale and Prashad
Fig. 193. C. Lateral view of ***Farrissia viola*** Annandale and Prashad

Type location : National Zoological Collection, ZSI, Regd. No. M 11718/2.

Latest name and Reference : *Ferrissia viola* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 83. *Zool. Surv. India.*

Diagnosis : Shell small, thin, opaque, suboval, slightly narrower behind. Length twice than broad, anterior slope slightly convex, posterior in position. Surface smooth with thin minute rugulose deposit. Dark brown or blackish in colour.

This species very much resembles *Ferrissia tenuis* (Bourguignat) but is distinguished by its brilliant internal colour and fine but distinct sculpture.

Distribution : India : Manipur : Bishenpur; Nagaland (Dimapur).

Found on the lower side of floating grass stems in a small sluggish muddy stream.

BIVALVIA

Bivalves are aquatic molluscs, bilaterally symmetrical and laterally compressed, elongated in anterior-posterior direction. They are provided with shell consisting of two wholly or partly calcified shells lying on the left and right side of the body. Typically the two valves are equal convexity, but in many forms bilateral symmetry is lost. The valves (except some cases) are connected dorsally by calcified, elastic structure called ligament and open and close by hinging along an axis. Typically the hinge axis is in anterio posterior direction. The two valves thus open along anterior, posterior and ventral margins. The valves close by the action of adductor muscle, attached on the inner side of shell may two or one. These muscles drawing the valves together, oppose the action of ligament which acts as spring tending to open them.

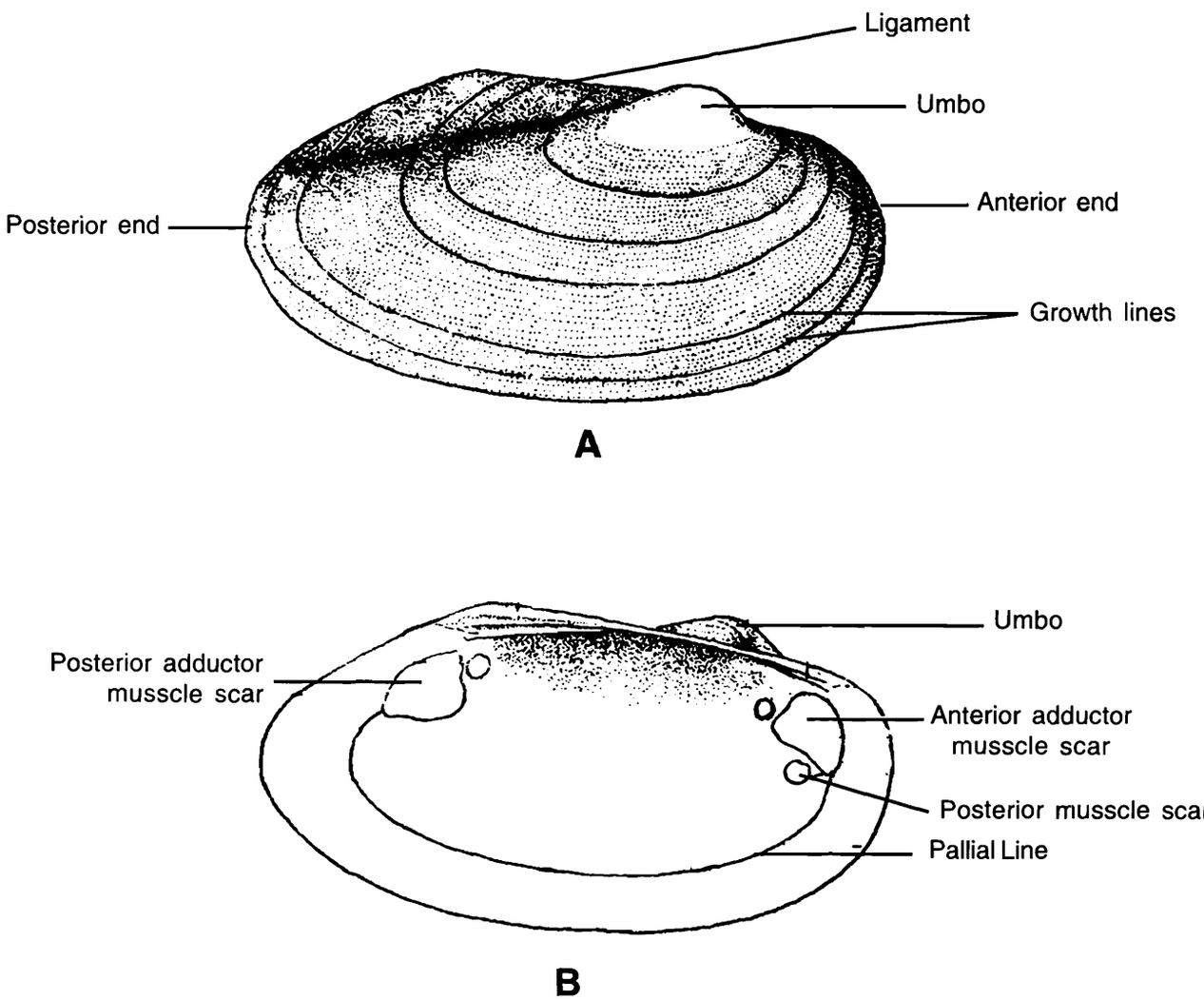


Fig. 194. A. Exterior view of shell of ***Lamellidens marginalis*** (Lamarck)
Fig. 194. B. Interior view of shell of ***Lamellidens marginalis*** (Lamarck)

Mantle consists of two lobes, on lining in each valve, joined dorsally but *elsewhere* their edges are either completely free or jointed only along part of their length. The body of molluscs occupies the dorsal position within the shell and mantle. Ventrally mantle encloses a large space called mantle cavity.

Animals are lack of head, radula, jaws and cephalic sensory organs. The mouth and anus are at opposite ends of the body and the intestine is convoluted to a varying extent. Mouth lies between the labial palps, which are two pairs ciliated flap like organs, assist in conducting food to it. Stomach is with a peculiar structure crystalline style, which aids the digestion of carbohydrates.

Foot is an extensile structure in bivalves serves mainly for burrowing. Gills or ctenidia are paired, present in the mantle cavity, and varies in structures. Nervous system with visceral and pedal ganglia, together with cerebral and pleural ganglia which are fused in most forms, but separate on some cases. A pedo-visceral commisure absent. Reproduction with copulation.

Habitat and Food

Bivalves are aquatic animals and no members of this class can respire, feed or remain active except aqueous medium. The period, for which any species can survive, inactive when removed from such environment depends largely on its capacity to close its two valves hermetically so that loss of moisture is reduced to a minimum. Freshwater bivalve's lives in pools which dry up periodically, particularly in summer are the most retentive of life to bivalves. Usually for aestivation they burrow more deeply into the muddy bottom before it becomes dry, but at times they merely lies loose on the floor of the former pool. Some Unionidae and Sphaeridae members are known to be dormant for the period of six months in every year and are capable of survive even more longer period.

The laterally compressed body of the bivalves well adapted for burrowing in sand or muddy substrates, with their extensile foot. They form an important element of the benthonic fauna, abundant in the sub littoral zone. Bivalves according to feeding habit may be suspension feeders or deposit feeders. The suspension feeders feed on phytoplankton; depend on the supply on the inhalant current in which large numbers of microscopic protists (chiefly diatoms and dinoflagellates) are suspended. These are strained off by ctenidia and conveyed to the mouth. Deposit feeders live on organic debris and bottom living diatoms present in the sand or mud in which they burrow. The organ used to collect the food is usually the inhalant siphon. In most cases is long and slender and not attached to the exhalant siphon, and its tip ranges over the surface of the sediment in search of food.

Morphology of soft parts

Mantle and Siphons : Mantle, the name given to the integument which surrounds the vital organs and which secrete the shells. It consists of two lobes, one corresponding in each valve and joined along the mid dorsal margin. Dorsal mantle lobes enclose the visceral mass and fused, but ventrally they surround a relatively large space, the mantle cavity, which plays fundamental role in the life of molluscs. It forms the respiratory chamber, enclosures for food must pass to reach the mouth and also receptacle into which excreta and genital products are discharge before expelled into the surrounding medium. Interchange of water from mantle cavity to exterior maintained by two currents an inhalant current (oxygenated and food bearing) and exhalant current (removes deoxygenated water and waste metabolism and the genital products). Exhalant current leaves the mantle cavity at its posterior end; inhalant current enters enters posteriorly in majority cases but in some cases it enters anteriorly and ventrally also.

Margin of mantle has three folds each having definite functions. The outer fold secretes the outer calcareous layer of shell and periostracum; the middle fold bears tentacles and sensory organs and the inner fold contains radial muscles, which attached to the interior of the shell along well definite line, the pallial line more or less parallel to the margin. They control the flow of water in and out of the mantle cavity. In the freshwater bivalves the mantle lobe margins are fused at a single place at posterior end of the mantle cavity to form a small opening through which the exhalant current passes, separated from the main opening, through which foot extruded and inhalant current passes.

Siphons are modification of the pallial muscles are contractile can be withdrawn partly or wholly inside the shell by the siphonal retractor muscles. To provide the space

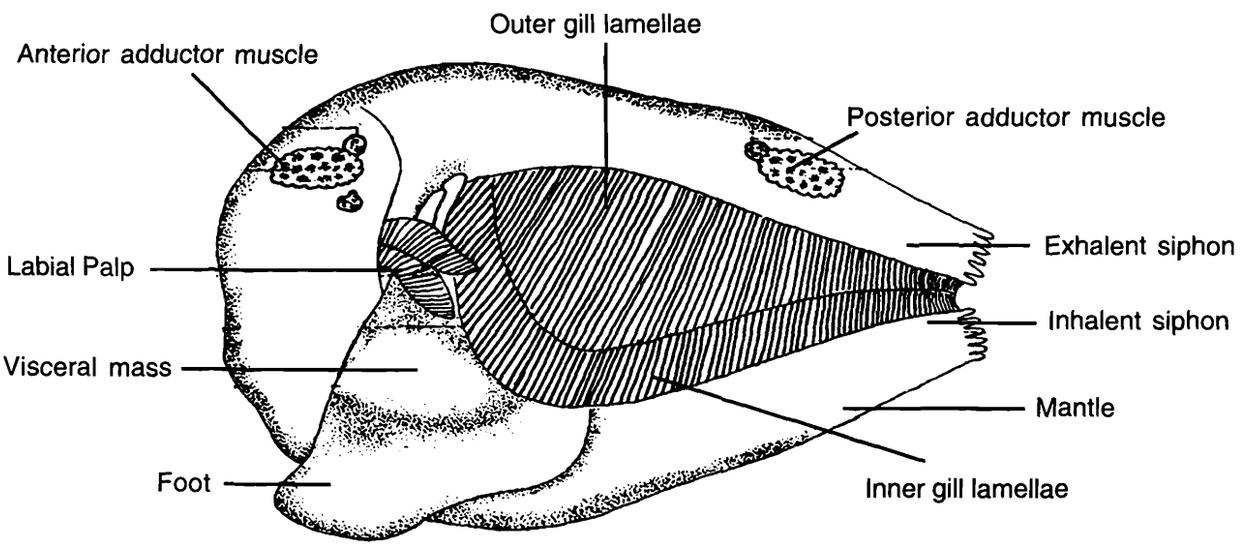


Fig. 195. ***Lamellidens marginalis*** (Lamarck) animal after removal of shell and a part of the mantle

for withdrawal of the siphons the line of insertion to these muscles recedes, gives rises an embayment in the pallial line, known as pallial sinus. The length of siphons varies depends on the depth if burrowing. Siphons are posterior in position.

Ctenidia and Labial palps : Ctenidia or gill are the organs of respiration and also an apparatus for collection of food in the bivalves. The extension of mantle cavity in anterio posterior direction along the whole body length provided space for enlargement of two ctenidia. They lies on each side of the cavity attached by membrane, with end to left and right of the foot, if they are not completely posterior or dorsal. The ctenidium consists of hollow longitudinally directed axis and a series of thin leaf like filaments attached on both sides. The structures on each side of the axis constitute a demibranch and most cases two demibranch are symmetrical. The demibranch may be inner or outer according to their position closer to sagittal plane.

The filaments of demibranch are narrow, elongated, teeth like structures, bent back itself so as to have a reflected limb which is attached to the axis. Each series of filaments limbs forms lamella and a typical ctenidium consists of four lamellae descending and ascending one in each demibranch. The lamellae are flat and thrown into folds or plicae. Each filament bears brush like structure called ciliated disc which interlock with those of the next filament and can be separated from them. The two demibranch jointed at intervals back to back and the junction bears a series of water pores or ostia, while the space between the two lamellae of the some demibranch is reduced to a series of transverse tubular cavities.

Labial pulps consist of two pairs acutely triangular, leaf like lamellae forming prolongations of the upper and lower lips of the mouth, physiological system same as ctenidia. When they occupy the normal positions the lamellae belonging to the upper lip fold down so that their jointed proximal ends are in front of the mouth and in each pair the one belonging to the upper lip lies on the outer side of the one belonging to the lower lip and termed as outer and inner lamellae.

The inner demibranchs of the two ctenidia are jointed to the foot and the outer demibranchs are jointed to the mantle. In the prosobranchs and many filibranchs the junctions are by inter locking cilia, but in others they are by vascular tissue. As a result a space (epibranchial chamber) dorsal to the ctenidia, is separated from the mantle cavity. This space is continuous with exhalent opening or siphon at the posterior end of the cavity. The water along with suspended particles strained off by the ctenidia posses through ostia or spaces between the filaments and then directed dorsally to the epibranchial chamber, along which it posses posteriorly to form the exhalent current.

Digestive System

The mouth is a small orifice lying behind the anterior adductor muscle. The mouth is continuous on each side by a groove called oral groove and bounded on each side by

labial palps. Above and below the mouth and oral groove are two lips, the raised folds of the epithelium covering the body.

Jaws or radula are absent, esophagus short and connected the mouth into a wide, thick walled oval sac the stomach into which the duct of digestive gland or liver open. The function of stomach to sort out and then pass to the intestine such indigestible matter which not already rejected by the ctenidia and labial palps and discharged from mantle cavity and carry out the preliminary digestion of nutritive matter.The posterior diverticulum of the stomach known as style sac secretes gelatinous rod like mucroprotein the crystalline style provided cellulose and starch digesting enzyme. The style sac lined by cilia which rotate and more the style forward so that its free end is projecting into stomach continuously with its distal end projecting into the stomach and its head bearing gastric shield. Thus the head worn away and the enzymes stired up with the contents of the stomach and digest the carbohydrates. The partially digested food passes through diverticula where intracellular digestion and absorption occur.

From the stomach the faecal matter passes into the intestine, which either emerges from the style sac or forms a separate tube close to it. The intestine first takes a ventral course and then forms one to several coil invade the upper part of foot and ascend dorsally and turn to posterior direction to form rectum which passes through posterior adductor and ends on postero dorsal side in the anus. Before reducing posterior adductor the rectum passes through pericardial cavity. The interior of intestine have a series of longitudinal grove and ridges known as typhosoles.

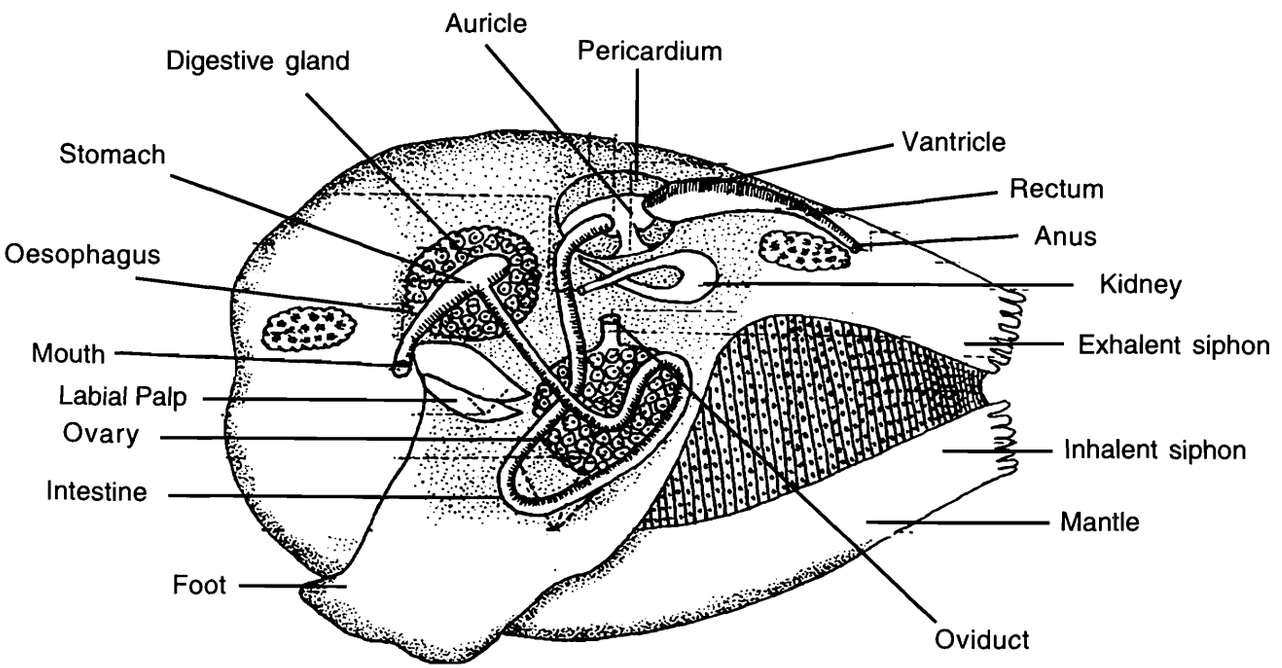


Fig. 196. Showing the different internal organs of ***Lamellidens marginalis*** (Lamarck) dissected animal

Circulatory system

The circulatory system is open type. It consists of : i) heart; ii) arteries; iii) sinuses; and iv) veins.

The heart present in pericardial cavity situated in the mid dorsal region of the body consists of a ventricle and two auricles or atria. The ventricle is elliptical in form extends along the whole length of the cavity and the auricles are large sacs lies on left and right sides and open into it by narrow canals. The ventricle surrounds the rectum and the two aortae originate from anterior and posterior ends of ventricle. The anterior aorta divided into various arteries, anterior pallial arteries – supply the blood to anterior part of mantle; gastro intestinal arteries – supply blood to the stomach and intestines; pericardial artery – supply to pericardial cavity; hepatic arteries – to digestive gland; pedal artery – to foot and other parts of animals. The posterior aorta is divided into two branches the posterior pallial arteries- supply the two sides of the posterior part of mantle and posterior adductor muscle. After traversing repeated subdivision the arteries blood went to irregular channels the blood sinuses. Within these sinuses in the epithelium of mantle the blood is oxygenated and some part of blood oxygenated through the ctenidia.

The venous system consisting of veins and sinuses, collect the blood distributed by artrial system and back to the heart.

Nervous system

The nervous system consists of three pairs of ganglia connected by commissures and connectives. The cerebropleural ganglia lie in anterior position behind the anterior adductor connected by each other by cerebral commissure which passes over the esophagus. The pedal ganglia close to foot and the visceral ganglia lie below the rectum. The pedal ganglia connected cerebro pleural ganglion by cerebro pedal connectives. The visceral ganglia are also jointed with cerebro-pleural ganglion by connectives. A pallial nerve run close to and more or less parallel to the mantle margin on each side and then connected anteriorly with cerebro-pleural ganglion and posteriorly with visceral ganglion.

Sense system

Sense organs are poorly developed due to its sedentary habits. The eyes and tentacles are absent in the bivalves. The sense organs are : i) statocytes; ii) osphridia; and iii) scattered sensory cells.

Statocytes are paired structures situated in the foot above the pedal ganglia. They are minute hollow structure, oval bodies which lie just below the epithelium and open into mantle cavity by a small canal. They are organs of equilibrium.

Osphradia are two pigmented sensory patches of the epithelium present on the wall of mantle cavity close to the attachment of the gills. They are probably the chemoreceptor.

The sensory cells are developed at infused parts of mantle edges and the extremities of the siphons. They are probably tactile and sensitive to light.

Reproductive system

Bivalves are dioecious but functional or simultaneous hermaphroditism was noticed in Sphaeridae and few species of Unionidae (Nagabhushanam and Lohgaonkar, 1978).

Gonads are paired structure placed symmetrically on two sides of visceral mass, forming a branching system of follicles surrounding the intestine. The ovary and testis are distinct glands, discharging their products through separate ducts. Gonoducts are paired and open into the pallial cavity by genital aperture in front of renal opening.

Various workers studied the gonodial activity of Indian bivalves. The annual cycle of *Parreysia corrugata* was studied by Lomte and Nagabhushanam (1969), *Lamellidens marginalis* by Ghosh and Ghosh (1972) and *L. corrianus* by Nagabhushanam and Lohgaonkar (1978).

Development of fertilized eggs (zygotes) proceeds within the outer demibranch which greatly enlarge due to large number of embryos serving as marsupia (brooding pouches). They have a larval stage (glochidium larva). Tremendous numbers of glochidia are produced in the outer gill laminae and after maturity they are expelled through the exhalant siphon into the water where they sink to the bottom and scattered by water currents. They grow further in the bottom and are scattered by water currents. They grow further in the gills of freshwater fishes and live as ectoparasite. They undergo metamorphosis to develop into young clams.

Key to the families

1. Shell internally non nacreous ..... (2)

– Shell internally nacreous ..... (6)

2. Hinge with numerous lamelliform teeth and edentulous in the middle ..... ARCIDAE

– Hinge with limited number of teeth but never edentulous ..... (3)

3. Shell elongate-quadrate, not ribbed ..... (4)

– Shell rounded, triangular to oval, concentrically striated or ribbed ..... (5)

4. Shell thick, hinge narrow and weak, siphon very long ..... PSAMMOBIIDAE

– Shell thin, hinge with three cardinal teeth, siphon not very long..... CULTELLIDAE

5. Shell thick and large; ligament very strong and external; hinge straight with three cardinal teeth and strong serrated anterior and posterior lateral teeth ..... CORBICULIDAE

– Shell thin and small; ligament not very strong and internal; hinge curved with two small cardinal teeth and smooth lateral teeth ..... PISIDIIDAE

6. Shell irregular, inequivalve and attached to substratum with one valve ..... AETHERIIDAE

– Shell regular, equivalve and valve not attached to substratum ..... UNIONIDAE

Class **BIVALVIA**
Subclass PTERIOMORPHIA
Order ARCOIDA
Superfamily ARCOIDEA
Family ARCIDAE

The family Arcidae contains species with small to large shell which are elongated-ovate, traphezoidal or rounded with elongated posterior end. Beaks are recurved. Area between beaks marked by chevron shaped ligamental groove. Ligament usually multivincular. Hinge line straight with numerous, regular sized teeth. The adductor scars are equal or unequal and connected by pallial line, byssal gap narrow or wide. Sculpture consist of smooth or granulose radial ribs. Shell covered with fibrous periostracum.

Animal having a stout, deeply grooved foot. Adductor muscles two of about equal strength. The border of mantle bear compound pallial eyes. The labial palps are direct continuation of the lips.

Found in intertidal region, often in muddy sand localities. Species are usually attached with a byssus to the substratum.

The members of the family are primarily marine in habitat. A few of them invade brackish and freshwater. Only one genus *Scaphula* is found in freshwater.

Subfamily ANADARINAE

Genus ***Scaphula*** Benson, 1834

1834. *Scaphula* Benson, *Proc. zool. Soc. Lond.*, **2** : 91.Type species : *Scaphula celox* Benson; subsequent designation, Benson, 1836.

Shell small, elongate, subtrapezoidal, equivalve, inequilateral; sculpture smooth most of the shell surface excepting at angle. Posterior umbonal carina narrow and high,

ligament external, hinge line straight with numerous subequal teeth, separated into two by middle edented portion. Posterior laminar teeth ramous sometimes, turning obsolately and obliquely into interior; muscle scars distinctive.

Occurs in India : Gangetic delta (West Bengal), Mahanadi river, Orissa, and Nagarjun sagar, Andhra Pradesh; Myanmar: Iravadi estuary, Thailand, Tenasserim river.

Ghosh (1922) described the anatomy of the genus. Three species of this genus are reported from India.

Key to the species

1. Shell very small (less than 10 mm), diagonal keel developed upto the extreme end of posterior extremity ..... *S. nagarjunai* Janaki Ram and Radhakrishna

– Shell small (more than 10 mm), diagonal keel not upto the extreme end of posterior extremity ..... (2)

2. Hinge teeth more oblique, posterior teeth further from extremity .. *S. celox* Benson

– Hinge teeth less oblique, posterior teeth nearer to extremity ..... *S. deltae* Blanford

Scaphula celox Benson, 1836

1836. *Scaphula celox* Benson, *J. Asiat. Soc. Beng.*, **5** : 750, pl. 7, figs. 2, 3. Type locality : Calcutta.

1867. *Scaphula celox* : Blanford, *J. Asiat. Soc. Beng.*, **36**(2) : 71, pl. 3, figs. 14, 15.

1915. *Scaphula celox* : Preston, *Fauna. Brit India*, Mollusca (Freshwater Gastropoda and Pelecypoda), : 129.

Fig. 197. A. Dorsal view of *Scaphula celox* Benson

Fig. 197. B. Ventral view of *Scaphula celox* Benson

Type location : Natural History Museum, London.

Latest name and Reference : *Scaphula celox* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 160, figs. 371-373 and 380,381.

Diagnosis : Shell small, tumid, inside of the valves white, elongately rhomboidal with a prominent keel along the diagonal teeth of the valve, hinge teeth 15-20, umbo much prominent.

Distribution : India : Madhya Pradesh : River Cane, near Banda (Bundel Khand); Orissa : Mahanadi; Uttar Pradesh, West Bengal: Hugli, North 24 Paraganas, Kolkata : Rabindra Sarobar, Kidderpore Dock.

MAP SHOWING THE DISTRIBUTION OF *Scaphula celox* Benson

Scaphula deltae Blanford, 1867

1867. *Scaphula deltae* Blanford, *J. Asiat. Soc. Beng.*, **36**(2) : 71, pl. 3, figs. 7-10. Type locality : Irrawaddy delta.

Fig. 198. A. Exterior view of *Scaphula deltae* Blanford

Fig. 198. B. Interior view of *Scaphula deltae* Blanford

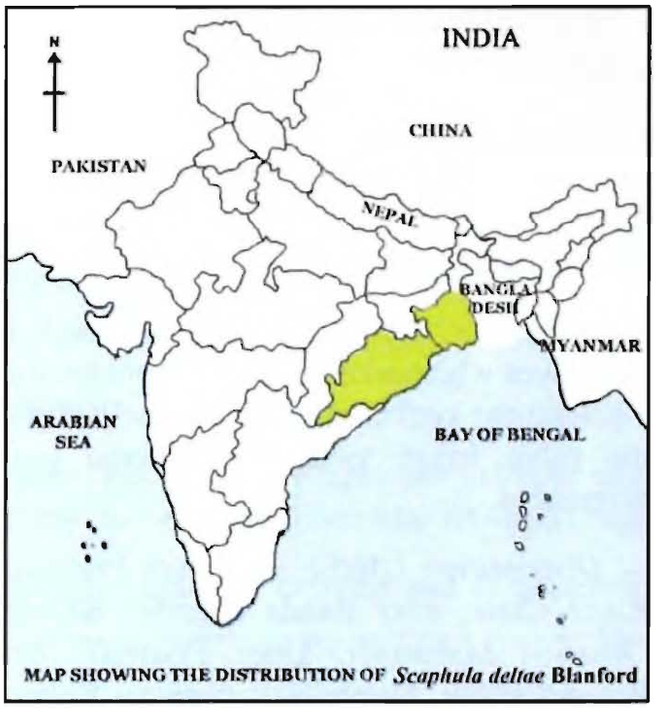
Type location : Natural History Museum, London.

Latest name and Reference : *Scaphula deltae* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 160, figs. 374-376.

Diagnosis : Distinguished from the other two species by its strong ribs parallel to the posterior keel and by the far greater tumidity of the valves, nearly twice as thick as the height.

Distribution : India : Gangetic delta, Kolkata : Rabindra Sarobar; Orissa : Mahanadi River.

Elsewhere : Myanmar.



MAP SHOWING THE DISTRIBUTION OF *Scaphula deltae* Blanford

Scaphula nagarjunai Janaki Ram and Radhakrishna, 1984

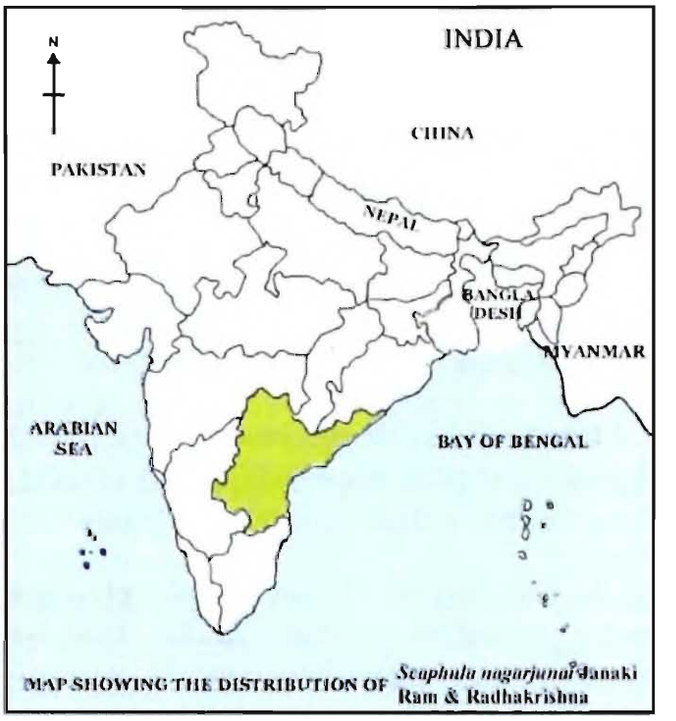
1984. *Scaphula nagarjunai* Janaki Ram and Radhakrishna, *Hydrobiologia*, **119** : 49-55. Type locality : Nagarjuna Sagar Lake, Guntur, Andhra Pradesh.

Fig. 199. Exterior view of *Scaphula nagarjunai* Janaki Ram and Radhakrishna

Type location : Not known.

Latest name and Reference : *Scaphula nagarjunai* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 211. *Zool. Surv. India.*

Diagnosis : Shell small elongate, subtrapizoidal, equivalve, with a high and acute posterior umbonal carina, conspicuously sculptured by close longitudinal and radial ribs, a few of the longitudinal rib are more raised, sculpture finer on lower half of the valves, below the carina, teeth on the hinge numerous.



Distribution : India : Andhra Pradesh : Guntur, Khammam.

Subclass PALEOHETERODONTA

Order TRIGOINOIDA

Superfamily UNIONOIDEA, Fleming, 1828

Shell equivalve, isomyarion, nacreous, except family Etheriidae where it is modified by attachment; periostracum heavy; umbo commonly with ornamentation; dentition when present consisting of rugose cardinals and posterior lamellar teeth.

Exclusively freshwater forms with larval stages parasitic to gill of fishes.

The freshwater mussels belongs to the superfamily Unionoidea are distinguished by the porcelain white to bluish or purple tinted pearly layer of their shells, rather variable in nature of dentition or lack of hinge teeth, various structures of soft parts and characters of larval development. Ecological modification of shells often creates problems to the taxonomists.

Shell characters : Shells having various outlines like circular to elongate, rod shape, flatly compressed to subglobular; varies in length 25 mm to 300 mm. Shell composed of three distinct layers: i) periostracum – composed of conchiolin, a horny organic cover, yellowish brown or black brown, smooth marked by colour bands radiating from umbo; ii) prismatic calcareous layer – forming hinge teeth; iii) nacreous layer – interior layer of calcium carbonate with lamellar structure consisting of aragonite. Shell sculpture in some cases smooth or merely shows growth lines, others partly or fully wrinkled or ribbed and there may be knobs, tubercle or even spinous projections, which remains constant within the limit of individual genus or species.

Hinge also varies greatly among this group. Hinge with prominent cardinals beneath or somewhat in front of beaks accompanied by less conspicuous long lamellar ridges behind the beak. Normally the dentitions consist of two cardinals and two posterior lamellar on the left valve matching sockets between the teeth of the opposite valve, but there is much variation in it. The teeth project from hinge plate (widened portion of the dorsal shell margin) persists in the tooth less space between cardinals and lamellar teeth. The cardinals are relatively persistent, those slender supported by fulcrum (strengthening deposit). The posterior lamellar teeth tend to be reduced and in many form disappear.

Inside the shell the beak cavity may be capacious and deep or small and shallow. Adductor muscle impression lacks special importance, but the pallial muscle are marked by an entire pallial line in most cases.

Larval stage : During the development from fertilized eggs, pass through a larval stage termed as glochidium. The first larval stage occurs at marsupium of the parent consisting of space between the pair of gill. The glochidia develop within the egg membranes feed exclusively on the egg yolk. After some time the larvae are expelled and further development on chance contact with a fish where the glochidium fixe itself by sticky thread and by hooks on its valves. As a cyst enclose the parasite in the flesh of fish, it takes nourishment from its host until it grows into a minute clam, when it pierces the skin of the fish and drops to the bottom of aquatic body is being traversed by its free swimming carrier.

Freshwater mussels of India are mostly known by their shell characters. Ghosh (1921) and Prashad (1918, 1919) studied the anatomy of the various Indian genera and attempt to apply these characters for classification of these groups. Ortmann (1910, 1911) proposed the classification based on anatomical characters. He also observed that shell characters are most useful for distinguished genera and species but the higher taxa can be different by using anatomical characters like structure of marsupium and larvae. Haas (1969) suggested that conchological characters are must useful for classification. Heard and Guckert (1970), Heard (1974) stressed the importance of soft parts, reproductive morphology and habits for classification of freshwater mussels.

According to Vaught (1989) this superfamily includes three families namely Margaritiferidae, Unionidae and Hyriidae, out of which only Unionidae is represented from Indian waters.

Family UNIONIDAE Fleming, 1828

Shell equivalve, nacreous; umbo generally sculptured and with remnant of larval shell; umbonal cavity deep; periostracum thick; ligament long, projecting; hinge with two cardinals and two posterior lamellar teeth in left valve and one cardinal and one lamellar tooth in right valve.

Gill with water tubes, all four gills or outer pair occupies by marsupium.

Geological range: Triassic to Recent.

This family included three subfamilies namely Unioninae, Anodontinae, Ambleminae. Indian genera are *Arcidopsis, Oxynaia, Physunio, Scabies, Solenaia* comes under subfamily Unioninae and the genera are *Lamellidens, Parreysia, Pseudodon* and *Trapezoideus* comes under subfamily Ambleninae.

The classification of the family with variable shell characters cannot be always taken as a reliable structure in classification. Subfamilies, genera and subgenera are mainly distinguished by gills and their relation to marsupium, mantle margin around inhalant siphons and larval form glochidium are also useful for the classification of freshwater mussels.

Prashad (1918, 1919) described the anatomy of many genera. Blanford (1866) attempts to revised Indian Unionids and pointed out the amount of variations among the group creates difficulty in classification. Prashad (1922) revised all the earlier workers on Indo Burmese Unionidae and made a revision of the Burmese unionidae but no attempt was made to revise the Indian genera.

Preston (1910) included nine genera under the family Unionidae. Later Prashad revealed that the species treated under *Nodularia* were to be included in the genus *Indonaia*, which is new synonymous with *Radiatula* Simpson.

Key to tha genera

1. Shell not soleniform, hinge with cardinal and lateral teeth ..... (2)

– Shell soleniform, hinge toothless (edentulous) ..... ***Solenaia*** Conrad

2. Shell with V-shaped tuberculate ridges on most of the shell ..... ***Scabies*** Haas

– Shell without V-shaped tuberculate ridges ..... (3)

3. Shell elongate ..... (4)

– Shell not elongate ..... (6)

4. Dorsal and ventral margin not parallel; cardinal teeth without fulcrum ..... (5)

– Dorsal and ventral margin almost straight and parallel; cardinal teeth short and supported by long fulcrum ..... ***Arcidopsis*** Simpson

5. Shell comparatively broader; posterior end broad; cardinal teeth elongate and compressed ..... ***Lamellidens*** Simpson

– Shell comparatively narrow; posterior end pointed; cardinal teeth stout ..... ***Oxynaia*** Haas

6. Shell trapezoidal, sub rhomboidal; posterior wing absent.....(7)

– Shell elliptical to ovate, narrow anteriorly; posterior wing present .....(8)

7. Umbo low; umbonal cavity shallow; cardinal tooth blunt, single without axillary tooth.....***Pseudodon*** Gould

– Umbo high; umbonal cavity deep; cardinal teeth elongated, with axillary tooth ....***Physunio*** Simpson

8. Shell trapezoidal; umbo low; cardinal teeth elongate without striation..... ..... ***Trapezoideus*** Simpson

– Shell subrhomboidal to rounded; umbo high with zig-zag radials; cardinal teeth compressed with vertical striatation ..... ***Parreysia*** Conrad

Subfamily UNIONINAE

Shell equivalve, umbonal sculpture concentric. Marsupium occupying all four gills or outer pair only.

Geological Range : Triassic to Recent.

This subfamily includes forty genera, of which five genera *Arcidopsis, Oxynaia, Physunio, Scabies* and *Solenaia* represented from Indian waters.

Genus ***Arcidopsis*** Simpson, 1900

1900. *Arcidopsis* Simpson, *Proc. U. S. natn. Mus.*, **22** : 861. (Type species : *Unio footei* Theobald, 1876; original designation).

Shell elongate, with short, straight and parallel dorsal and ventral margin, rather compressed and rounded in front, high, long, obliquely and roundedly truncate and inflated behind; posterior slope ill defined; periostracum black; sculptured with fine concentric and radial ridges; hinge with short and strong cardinal teeth, supported by strong, riblike fulcrum; lamellar teeth short, muscle scars well impressed; pallial line distinct.

Geological Range : Recent

India. Monotypic

Arcidopsis footei (Theobald, 1876)

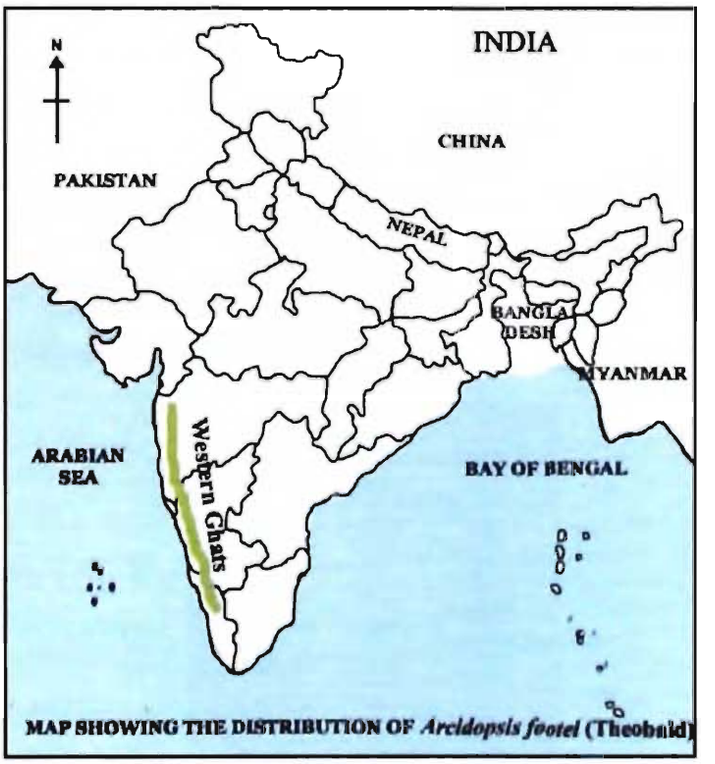
1876. *Unio footei* Theobald, *J. Asiat. Soc. Beng.*, **45** : 187, pl. 14, figs. 9, 9a. Type locality : Gutparba falls, Krishna River.

1915. *Arcidopsis footei* : Preston, *Fauna. Brit India* Mollusca, (Freshwater Gastropoda and Pelecypoda), p. 196.

Fig. 200. A. Exterior view of *Arcidopsis footei* (Theobald)

Fig. 200. B. Interior view of *Arcidopsis footei* (Theobald)

Type location : Prashad (1920) raised doubts as to the existence of types and hence created Neotypes, Regd. No. M 7673/1, M 7675/1, present in National Zoological Collection, ZSI. The specimen bearing Regd. No. M 7676/1 is not available.



Latest name and Reference : *Arcidopsis footei* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 169, figs. 414, 415.

Diagnosis : Shell elongate, a strong ridge running back and down from the beaks, ventrally strongly compressed in the anterior region.

Prashad (1920) made comments on the relationships and type locality of the species and added to the previous descriptions.

Distribution : India : River system of Western Ghats.

Genus ***Physunio*** Simpson, 1900

1900. *Physunio* Simpson, *Proc. U.S. natn. Mus.*, **22** : 828. Type species: *Unio gravidus* Lea, 1856, Original designation.

Shell thin, irregularly obovate with narrow anterior end, produced at posterior base; posterior slope high, winged excavated with a distinct posterior ridge; umbo inflated with deep cavities and zigzag folds; surface smooth; hinge with compressed, elongated cardinal teeth, lamellar teeth short, somewhat curved, auxiliary tooth present at older shells; periostracum yellowish or brownish green.

Animals with smooth exhalent aperture, inhalant aperture with elongated tentacles arranged in three rows. Marsupium present in the middle region of outer gill, formed by simple water tubes 11 to 17 in numbers. Glochidium hookless.

Prashad (1918) described the marsupium and glochidium and Ghosh (1919) worked out the detail anatomy of the genus.

Geological Range : Recent.

Distribution : South-east Asia, Java.

Subgenus ***Velunio*** Haas, 1914

1914. *Velunio*, Haas, *Syst. Conch. Cab. (N.F.)*, **9(2)** : 276.Type species : *Unio velaris* Sowerby, 1868; Original designation.

Shell compressed with well developed wings; Umbo elevated and incurved forward.

Geological Range : Recent.

Distribution : South-east Asia.

Physunio (Velunio) velaris (Sowerby, 1868)

1868. *Unio velaris* Sowerby, in Reeve's *Conch Icon.*, **16** : *Unio*, pl. 72, fig. 368. Type locality : Assam.

Fig. 201. A. Exterior view of *Physunio (Velunio) velaris* (Sowerby)

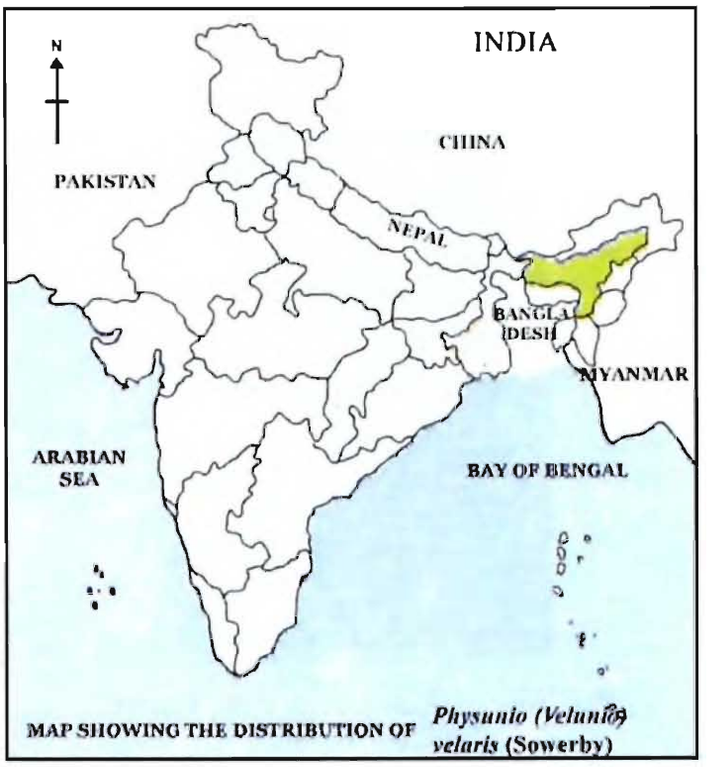
Fig. 201. B. Interior view of *Physunio (Velunio) velaris* (Sowerby)

1900. *Physunio (Lens) velaris* : Simpson, *Proc.U.S. natn. Mus.*, **22** : 831.

1915. *Physunio (Lens) velaris* : Preston, *Fauna. Brit India,* Mollusca (Freshwater Gastropoda and Pelecypoda, p. 149.

Type location : Natural History, Museum, London.

Latest name and Reference : *Physunio (Velunio) velaris* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 197, figs. 416, 417.



Diagnosis : Shell small, thin rather compressed; sculpture smooth; anterior extremity very narrow; posterior side winged, ventral margin arcuated, rising abruptly anteriorwards, beaks very acute, prominent, lunule excavated; cardinal teeth large, lamellar approximate; pale green, nacre white.

Distribution : India : Assam.

Genus *Scabies* Haas, 1911

1911. *Scabies* Haas, *Syst. Conch. Cab. (N.F.),* **9**(2) : 105. Type species : *Unio scobinatus* Lea, 1856; original designation.

Shell elongated, elliptical, not as thick as in genus *Parreysia*; periostracum yellowish brown; sculpture with V-shaped tuberculate ridges throughout the shell; right posterior lateral tooth with auxiliary tooth beneath posterior extremity.

Geological Range : Recent

East Asia.

Scabies crispata (Gould, 1843)

1843. *Unio crispata* Gould, *Proc. Boston Soc.nat. Hist.*, **1** : 141. Type locality : Tavoy, Myanmar.

1856. *Unio scobinatus* : Lea, *Proc. Acad.nat. Sci. Philad.*, **8** : 93. Type locality : Siam.

1856. *Unio scobina* : Hanley, *Recent Bivalve Shells,* : 382, pl. 23, fig. 40.

1915. *Nodularia (Nodularia) scobina* : Preston, *Fauna Brit India,* Mollusca. (Freshwater Gastropoda and Pelecypoda), p. 142.

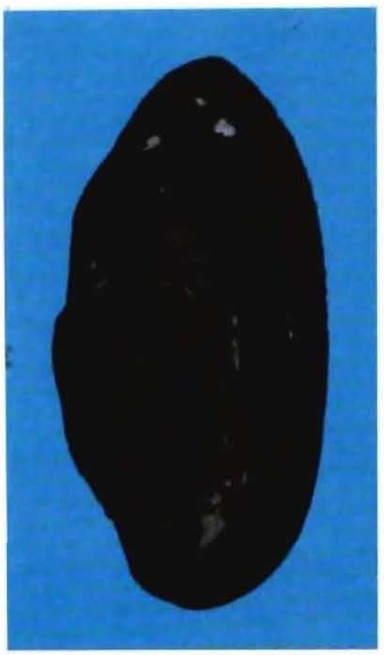


Fig. 202. A. Exterior view of *Scabies crispata* (Gould)

Fig. 202. B. Interior view of *Scabies crispata* (Gould)

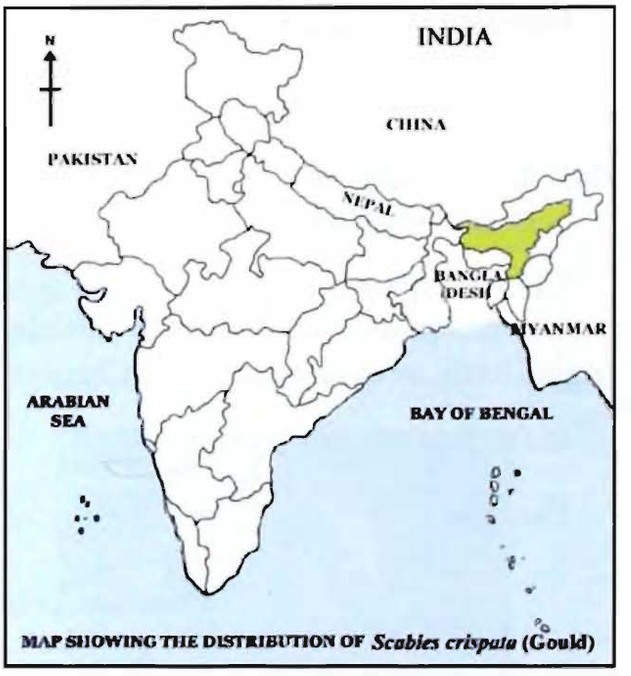
1915. *Nodularia (Nodularia) crispata* : Preston, *Fauna Brit India,* Mollusca. (Freshwater Gastropoda & Pelecypoda), p. 142.

1921. *Indonaia scobina* : Prashad, *Rec. Indian Mus.*, **22** : 603.

1974. *Scabies crispata* : Brandt, *Arch. Moll.*, **105** : 281, pl. 20, fig. 33.

Type location : Not known.

Latest name and Reference : *Scabies crispata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 193, figs. 544, 545.



Diagnosis : Shell strongly and deeply sculptured, zig-zag radial lines, interspersed here and there with thicker nodules on yellowish to brownish background, ridges transverse in the anterior region and vertical in the posterior region of the shell.

Brandt (1974) dealt in detail and remarked on the possibility of three geographic races within its area of distribution.

Distribution : India : Assam : Sibsagar.

Elsewhere : Cambodia, Myanmar : Tavoy, Bhamo; Siam : Battambong; Thailand.

Genus ***Solenaia*** Conrad, 1868

1868. *Solenaia* Conrad, *Am. J. Conch.* **4** : 246. Type species : *Mycetopus emarginatus* Lea, 1860; original designation.

Shell very elongated, soleniform, rather thin; anterior end narrow, rounded with strongly sulcate upper part, gaping at anterior base and behind, with strong posterior ridge ends below posterior extremity; umbo narrow, not prominent; periostracum ray less, sculptured with looped concentric ridges; hinge narrow, cardinals absent, one or more vestigial laterals present in each valve; pallial line distinct with pallial sinus. Foot large with swollen anterior end in the form of a bowl.

Geological Range : Cretaceous to Recent

China, South-east Asia.

Solenaia soleniformis (Benson, 1836)

1836. *Anodon soleniformis* Benson, *J. Asiat. Soc. Beng.*, **5** : 750. Type locality : Assam.

1900. *Solenaia soleniformis* : Simpson, *Proc.U. S. natn. Mus.*, **22** : 656.

1900. *Solenaia soleniformis* : Preston, *Fauna. Brit. India.* Mollusca. (Freshwater Gastropoda and Pelecypoda), p. 132.

1919. *Balwantia soleniformis* : Prashad, *Rec. Indian Mus.*, **16**:290, Text fig., 1.

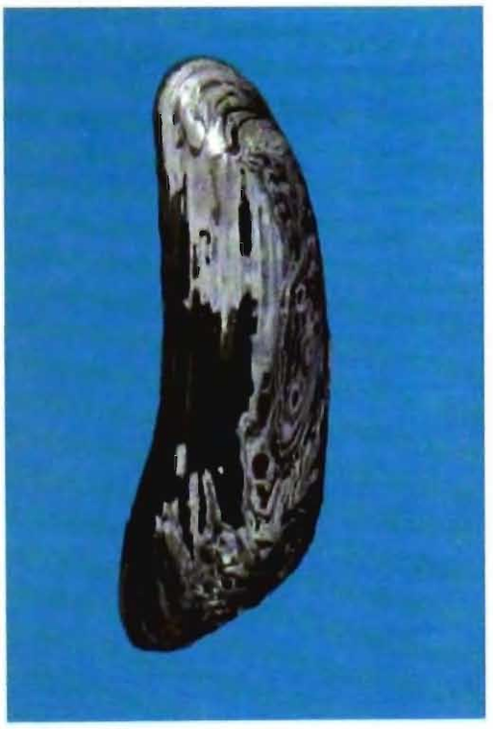


Fig. 203. A. Exterior view of *Solenaia soleniformis* (Benson)

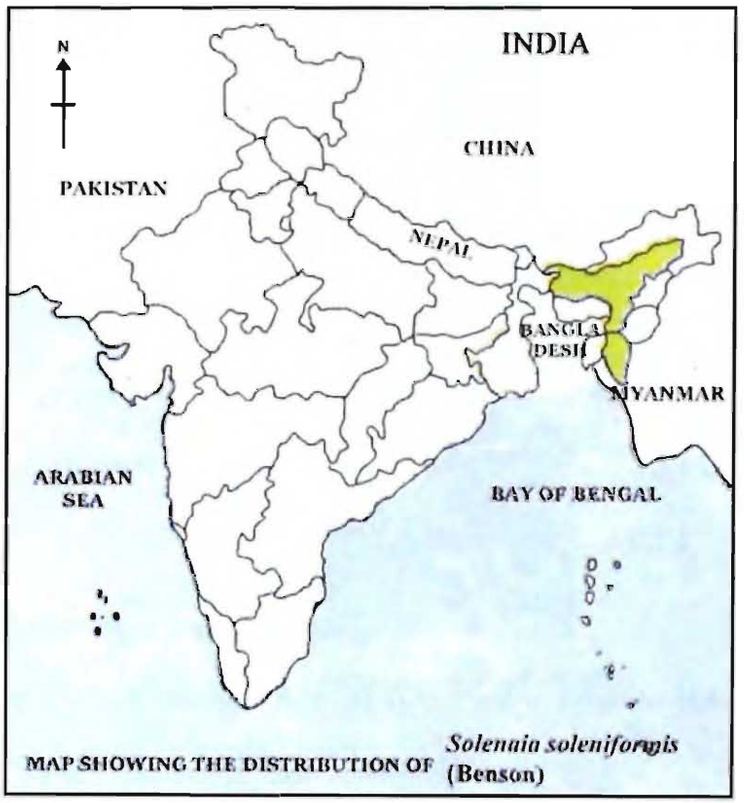
Fig. 203. B. Interior view of *Solenaia soleniformis* (Benson)

Type location : National History Museum, London.

Latest name and Reference : *Solenaia soleniformis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 175, figs., 442, 443.

Diagnosis : Shell soleniform, elongate and rather narrow, compressed, anterior end narrower, posterior end broader and sloping; hinge without teeth.

Distribution : India : Assam: Daleswari, in Barak River, Cachar; Mizoram.



MAP SHOWING THE DISTRIBUTION OF *Solenaia soleniformis* (Benson)

Remarks : Hora (1926) studied the distribution and habits of this species. In Mizoram large numbers of shells of this species are collected by local people for their consumption.

Subfamily AMBLEMINAE (Quadrulinae)

Shell heavy, high, squarish to triangular, shape varies with sexual dimorphism; beak ornamented with W or V-shaped folds, degenerating in some into row of tubercles; hinge angular, heavy. Marsupium occupying all four gills.

Geological range: Lower Cretaceous to Recent.

This subfamily includes sixty genera. In India it is represented by three genera viz. *Lamellidens, Parreysia* and *Trapezoideus.*

Tribe **Amblemini**

Genus ***Lamellidens*** Simpson, 1900

1900. *Lamellidens* Simpson, *Proc.U.S. natn. Mus.*, **22** : 854. Type species: *Unio marginalis* Lamarck, 1819; original designation.

Shell moderately thick, elongate elliptical; anterior end narrow and curving regularly; posterior end broad with a post dorsal wing, a low, often biangulate posterior ridge and also two sharpe radiating lirae; umbo curved radiating ridges of zigzag shaped and concentric reaching about halfway from beak and fading out gradually; periostracum

smooth; brownish or dark, shiny and ray less; hinge with two elongated cardinals and two laterals in the left valve and right valve with two parallel lamellar cardinals and one laterals.

Exhalent aperture with a row of minute tubercles at its extreme lateral margins, inhalant aperture with a single row of stout and short tubercles.

Geological Range : Miocene to Recent.

India, Bangladesh, Myanmar, Pakistan.

Ghosh (1918) described details of the comparative anatomy of the genus *Lamellidens, Solenaia* and *Physunio*. Prashad (1918, 1910) described the marsupium, glochidium and anatomy of the genus *Lamellidens, Parreysia, Physunio* and *Radiatula* (*Indonaia).*

Key to the species

1. Posterior wing well developed ..... *L. generosus* (Gould)

– Posterior wing feebly developed or absent .....(2)

2. Posterior end elongate, shell narrow .....(3)

– Posterior end not elongate, gradually sloped, shell broad.....(4)

3. Shell elongately ovate, less thick, umbones flat, anterior side angled, posterior margin obtusely rounded ..... *L. phenchooganjensis* Preston

– Shell transversely elongated, thick, broader, umbones more distinct and convex, anterior end short and rounded, posterior side sloping..... *L. jenkinsianus* (Benson)

4. Shell broad, dorsal margin obliquely truncate posterior end... *L. consobrinus* (Lea)

– Shell narrower, dorsal margin gradually sloping posteriorly .....(5)

5. Umbo prominent, colour brown with a lighter band along the margin .... *L. marginalis* (Lamarck)

– Umbo less prominent, colour uniformly dark ..... *L. corrianus* (Lea)

Lamellidens consobrinus (Lea, 1859)

1859. *Unio consobrinus* Lea, *Proc. Acad. Nat. Sci. Philad.*, **3** : 331. Type locality : China.

1921. *Lamellidens consobrinus* : Prashad, *Rec. Indian Mus.*, **22** : 608.

1989. *Lamellidens consobrinus* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 164, figs., 384, 385.

Fig. 204. A. Exterior view of *Lamellidens consobrinus* (Lea)

Fig. 204. B. Interior view of *Lamellidens consobrinus* (Lea)

Type location : ANSP (Paratype), USNM (Holotype).

Latest name and Reference : *Lamellidens consobrinus* : Mitra, Dey and Ramakrishna, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 211. *Zool. Surv. India.*

Diagnosis : Shell rhomboidal, thick, umbones more inflated than in *L. marginalis*, dorsal margin curved and obliquely truncate, posterior side obtusely angled, anterior side rounded, left valve with two ragged cardinals, anterior large and more developed.

Distribution : Andhra Pradesh, Maharashtra, Pondicherry, Tamil Nadu.

Elsewhere : Bangladesh, China, Sri Lanka.

Lamellidens corrianus (Lea, 1834)

1834. *Unio corrianus* Lea, *Trans. Amer. Philos. Soc.*, **6(2)** : 65, pl. 9, fig. 25. Type locality : India.

1900. *Lamellidens corrianus* : Simpson, *Proc. U. S. natn. Mus.*, **22** : 857.

1921. *Lamellidens corrianus* : Prashad, *Rec. Indian Mus.*, **22** : 609, fig. 29c.

1989. *Lamellidens corrianus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 165, figs. 386, 387.

Fig. 205. A. Exterior view of *Lamellidens corrianus* (Lea)

Fig. 205. B. Interior view of *Lamellidens corrianus* (Lea)

Fig. 206. A. Exterior view of *Lamellidens narainporensis* Preston

Fig. 206. B. Interior view of *Lamellidens narainporensis* Preston

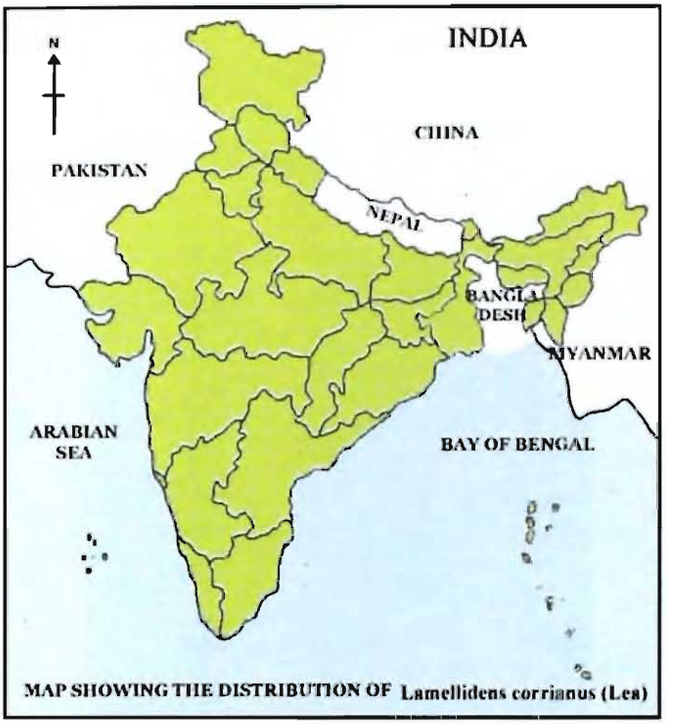
Type location : USNM

Latest name and Reference : *Lamellidens corrianus* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 212. *Zool. Surv. India.*

Diagnosis : Shell elongate, elliptical; umbone slightly inflated; periostracum smooth and dark brown; dorsal margin almost straight and long; cardinals two in each valve.

Distribution : Common throughout India.

Elsewhere : Bangladesh and Myanmar



Lamellidens generosus (Gould, 1847)

1847. *Unio generosus* Gould. *Proc. Boston Soc. nat. Hist.*, **2** : 220. Type locality : Tavoy, Myanmar.

1922. *Lamellidens generosus* : Prashad, *Rec. Indian Mus.*, **24** : 107, pl. 2, figs. 12-17.

1989. *Lamellidens generosus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 165, figs. 388, 389.

Fig. 207. A. Exterior view of *Lamellidens generosus* (Gould)

Fig. 207. B. Interior view of *Lamellidens generosus* (Gould)

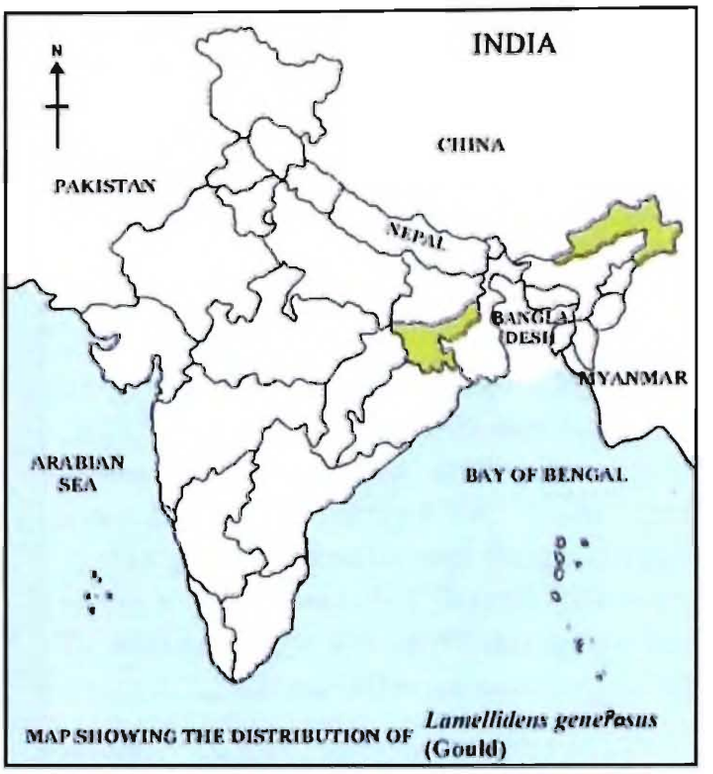
Type location : USNM

Latest name and Reference : *Lamellidens generosus* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 86. *Zool. Surv. India.*

Diagnosis : Shell solid, oblong-ovate, anterior rounded, posteriorly oblique, subrostrate, dorsal margin straight, ventral margin arcuate, posterior wing narrow in adults.

Distribution : India : Arunachal Pradesh, Jharkhand : West Sighbhum (Chakradharpur)

Elsewhere : Myanmar.



Lamellidens jenkinsianus (Benson, 1862)

1862. *Unio jenkinsianus* Benson, *Ann. Mag. Nat. Hist.*, **(3) 10**: 185. Type locality : "Berhampooter river, Assam".

1920. *Lamellidens jenkinsianus* : Prashad, *Rec. Indian Mus.*, **19** : 172. pl. ix, figs. 3,4.

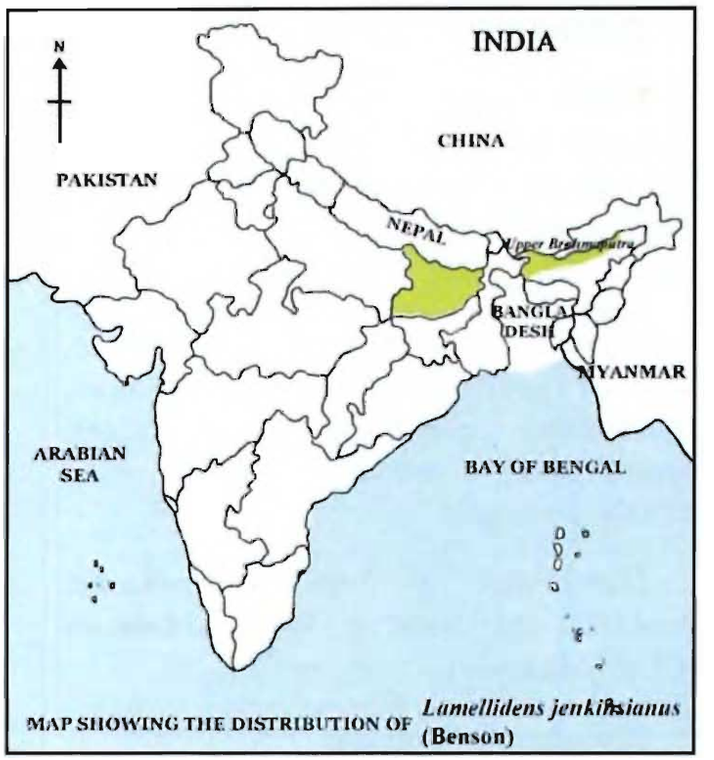
Fig. 208. A. Exterior view of *Lamellidens jenkinsianus* (Benson)

Fig. 208. B. Interior view of *Lamellidens jenkinsianus* (Benson)

Type location : Natural History, Museum, London.

Latest name and Reference : *Lamellidens jenkinsianus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 166, figs. 390, 391.

Diagnosis : Shell transversely elongated, thick, tumid, anterior end short and rounded, posterior side sloping, right valve with two cardinals, lower long, thick and heavily built and very ragged, upper one usually thin, a single blade like lateral, left valve with a small pad-like tooth from the inner margin of the umbo, two lamellar teeth.



MAP SHOWING THE DISTRIBUTION OF *Lamellidens jenkinsianus* (Benson)

Distribution : India : Assam : Upper Brahmaputra (Tezpur); Bihar : Bhagalpur.

Elsewhere : Bangladesh: Dacca, Sylhet.

Remarks : Prashad (1920) gave synonymy and added to the earlier description.

Lamellidens jenkinsianus sub sp. ***daccaensis*** (Preston, 1912)

1912. *Parreysia daccaensis* Preston, *Rec. Indian Mus.*, **7** : 300. Type locality : Dacca.

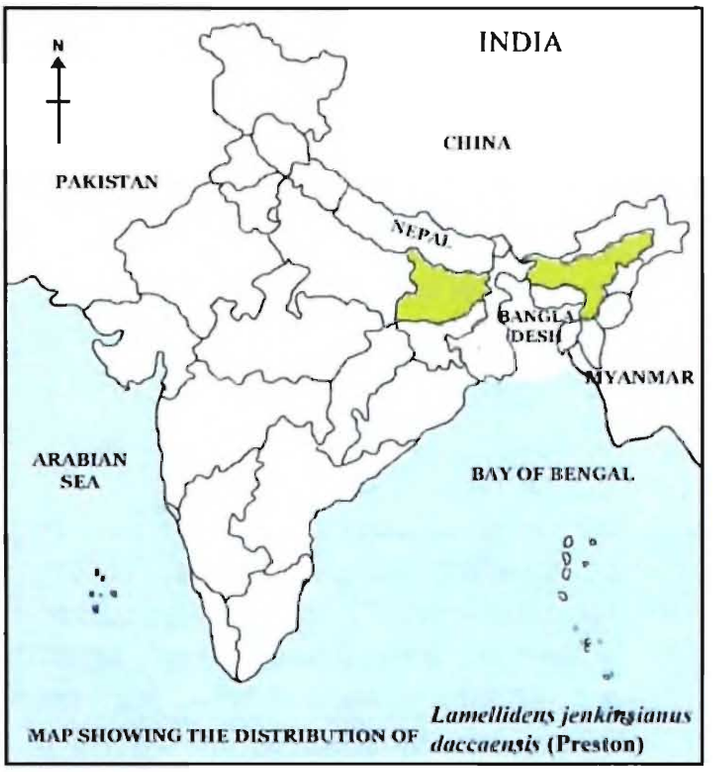
1920. *Lamellidens jenkinsianus* sub. sp. *daccaensis* : Prashad, *Rec. Indian Mus.*, **19** : 173, pl. 9, figs. 5-8.

Fig. 209. A. Exterior view of *Lamellidens jenkinsianus* sub sp. *daccaensis* (Preston)

Fig. 209. B. Interior view of *Lamellidens jenkinsianus* sub sp. *daccaensis* (Preston)

Type location : National Zoological Collection, ZSI, Regd. No. M 6105/1.

Latest name and Reference : *Lamellidens jenkinsianus* sub sp. *daccaensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 167, figs. 394-397.



Diagnosis : Shell shorter, broader, elongately ovate, more convex; umbo more distinct; sculpture much more coarsely concentrically striate and is also considerably malleated; dorsal margin more arched than the typical form; darker in colour, being of a dark blackish-brown; left valve with small pad like tooth from the inner margin of umbo and two lateral; right valve with two cardinals, lower one thick and heavy and ragged, upper one thin, lateral tooth single blade like.

Distribution : India : Assam, Bihar : Bhagalpur.

Elsewhere : Bangladesh : Dacca, Mirpur, Nababgang (Jessore Dist) and Sylhet.

Lamellidens jenkinsianus sub sp. ***obesa*** (Hanley and Theobald, 1877)

1877. *Unio marginalis obesa* Hanley and Theobald, *Conch. Indica*, : 20, pl. 12, fig. 3. Type locality : Irawaddy River, Myanmar.

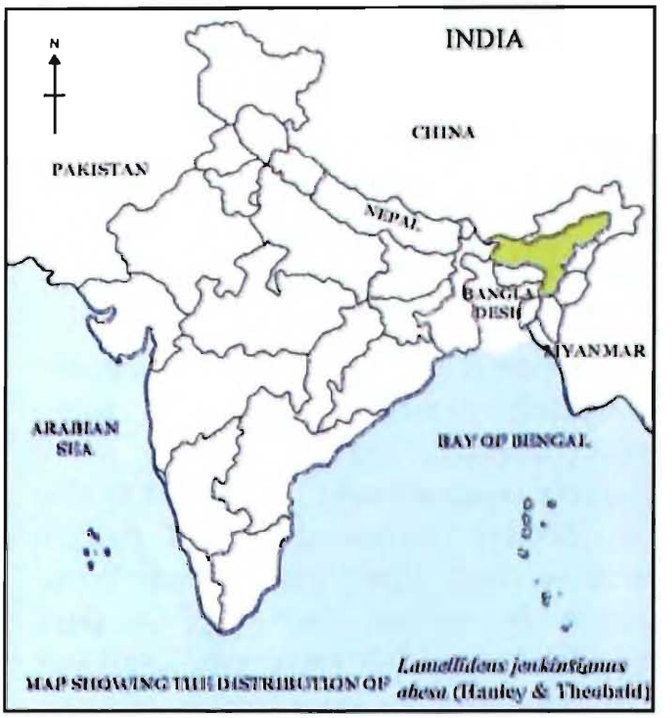
Fig. 210. A. Exterior view of *Lamellidens jenkinsianus* sub sp. *obesa* (Hanley and Theobald)

Fig. 210. B. Interior view of *Lamellidens jenkinsianus* sub sp. *obesa* (Hanley and Theobald)

1920. *Lamellidens jenkinsianus* sub sp. *obesa* : Prashad, *Rec. Indian Mus.*, **19** : 170, pl., 9, figs. 1, 2.

Type location : National History Museum, London.

Latest name and Reference : *Lamellidens jenkinsianus* sub sp. *obesa* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 167, figs. 392, 393.



Diagnosis : Shell thick, elongate, convex, greatly inflated, posteriorly spatulate, anterior margin broad, regularly curved, posterior margin narrow, round, posterior ridge straight or slightly curved with a narrow post dorsal wing; upper anterior tooth almost linear; laterals not bent at the extremity, upper one in the left valve scarecely developed.

Distribution : India : Assam.

Elsewhere : Bangladesh; Myanmar

Lamellidens marginalis (Lamarck, 1819)

1819. *Unio marginalis* Lamarck, *Hist. Nat. Anim. Sans. Vert.*, **4** : 79. Type locality : Bengal.

1900. *Lamellidens marginalis* : Simpson, *Proc. U.S. natn. Mus.*, **22** : 854.

Fig. 211. A. Exterior view of *Lamellidens marginalis* (Lamarck)

Fig. 211. B. Interior view of *Lamellidens marginalis* (Lamarck)

1921. *Lamellidens marginalis* : Prashad, *Rec. Indian Mus.*, **22** : 606, fig. 29A.

1989. *Lamellidens marginalis* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 168, figs. 404, 405.

Type location :

Latest name and Reference : *Lamellidens marginalis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 212. *Zool. Surv. India.*

Diagnosis : Shell oblong ovate, valves covered by blackish brown periostracum with light brown border along ventral margin, umbo not elevated, posterior side broad, roundedly angular, margin produced, narrow wing, dorsal margin slightly curved, central margin slightly contracted in middle, hinge with two cardinals in right valve, interior nacreous.

Distribution : India : Widely distributed.

Elsewhere : Bangladesh; Myanmar and Sri Lanka.

Lamellidens phenchooganjensis Preston, 1912

1912. *Lamellidens phenchooganjensis* Preston, *Rec. Indian Mus.*, **7** : 306. Type locality : Phenchooganj, Central Sylhet (Bangladesh).

Fig. 212. A. Exterior view of *Lamellidens phenchooganjensis* Preston

Fig. 212. B. Interior view of *Lamellidens phenchooganjensis* Preston

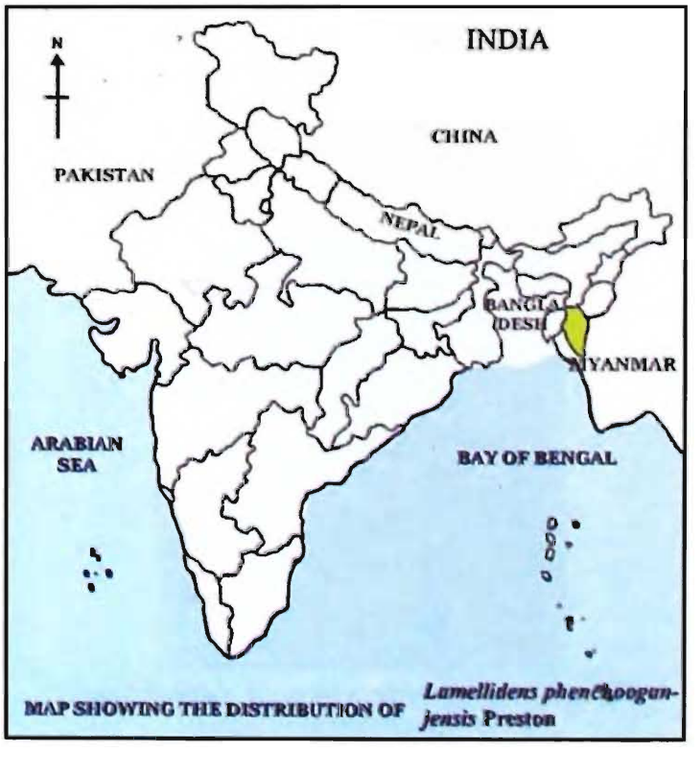
Fig. 213. A. Exterior view of *Lamellidens phenchooganjensis* Preston (Holotype)

Fig. 213. B. Interior view of *Lamellidens phenchooganjensis* Preston (Holotype)

Type location : National Zoological Collection, ZSI, Regd. No. M 4868/1 (Holotype).

Latest name and Reference : *Lamellidens phenchooganjensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 168, figs. 406, 407.

Diagnosis : Shell elongatedly ovate, posteriorly obtusely rostrate, dark blakish-brown, sculpture with fine concentric striae, crossed, specially in the anterior median region, by fine, slightly distant, transeverse, radiate striae, thus pressenting a minutely wrinkled appearance; umbones flattened, much eroded; dorsal margin anteriorly gently sloping, posteriorly more rapidly sloping in a slight curve; ventral margin scarcely rounded; anterior side angled above, gently rounded below; posterior side produced, angularly rounded; hinge-teeth very elongated, somewhat fine; anterior adductor scars ovate, moderately impressed; posterior adductor scars roughly triangular, not well impressed; interior of shell shading from pale brown to bluish, nacreous, marked, especially towards the anterior ventral region, with very shallow radiated furrow.



Distribution : India : Mizoram.

Elsewhere : Bangladesh : Phenchooganj, Central Sylhet

Remarks : The studied materials are bigger and thicker than the Holotype.

Genus ***Parreysia*** Conrad, 1853

1853. *Parreysia* Conrad, *Proc. Acad nat. Sci. Philad.*, **6** : 267. (Type species : *Unio multidentatus* Philippi, 1847; original designation).

Shell rounded to subrhomboid, heavy, inflated, with distinct, radial zig-zag ribs on umbonal region; periostracum smooth, bright rayed; hinge with strong cardinals, ragged or vertically striate, lateral teeth short, in some duplicated in right valve; cavity of beaks rather deep.

Animals with all four marsupial gills; supra and opening widely separated from the anal; inner lamina of the inner gill connected with the abdominal sac.

Ortmann (1910) distinguished this genus from the others genera and was of opion that it is very similar with genus *Quadrula* a north American genus. Preston (1920) listed 20 species and varities of the genus *Parreysia.*

Geological range : Miocene to Recent.

India, Myanmar and other South-east Asia countries and central Africa.

Two distinct subgenera *Parreysia* and *Radiatula* are recognised from India.

Key to the subgenera

– Shell thick, ventral margin convex, swollen at centre; beak sculpture strong .... *Parreysia* Conard

– Shell comparatively thin, ventral margin almost straight; beak sculpture not strong with radiating or zigzag shaped or divaricate ridges ..... *Radiatula* Simpson

Subgenus ***Parreysia*** s. st.

Shell with swollen at central of ventral margin; umbo with strong sculpture, central ridges united at their lower part to form chevron shaped markings.

Geological Range : Miocene to Recent.

South-east Asia.

Key to the species

1. Shell very heavy, more than 50 mm; posterior end tapering .... *P. (P.) triembolus* (Benson)

– Shell not so heavy, less than 50 mm; posterior end not tapering .....(2)

2. Shell with corrugated sculpture either on umbonal region or in the anterior margin .....(3)

– Shell without corrugated sculpture on the body .....(4)

3. Corrugated sculpture on umbonal region; posterior end broad .... *P. (P.) corrugata* (Mueller)

– Corrugated sculpture on the anterior margin; posterior end acute .... *P. (P.) burmanus* (Blanford)

4. Shell with angulated ridges at posterior end .....*P. (P.) rajahensis* (Theobald)

– Shell without angulated ridges at posterior end.....(5)

5. Anterior end short, less than $^1/_3$rd of the total length; lunule not well marked ...(6)

– Anterior and posterior almost equal; beaks submedian and deflected forward with a deep cavity; lunule well marked ..... *P. (P.) smaragdites* (Benson)

6. Shell small, comparatively thin, concentric zones of bluish green and ochraceous yellow ..... *P. (P.) corbis* (Benson)

– Shell medium, comparatively thick, concentric zones of brownish-yellow.....(7)

7. Shell quadrately ovate, posterior dorsal margin above the umbo .... *P. (P.) gowhattensis* (Theobald)

– Shell elliptic to ovate, posterior dorsal margin below umbonal region.....(8)

8. Umbo more elevated, anterior end short; cardinal teeth not so strong broad ..... *P. (P.) sikkimensis* (Lea)

– Umbo less elevated, anterior end short; cardinal teeth strong and broad .... *P. (P.) favidens* (Benson)

Parreysia (Parreysia) annandalei Preston, 1912

1912. *Parreysia annandalei* Preston, *Rec. Indian Mus.*, 7 : 302. Type locality : Gowhatty.

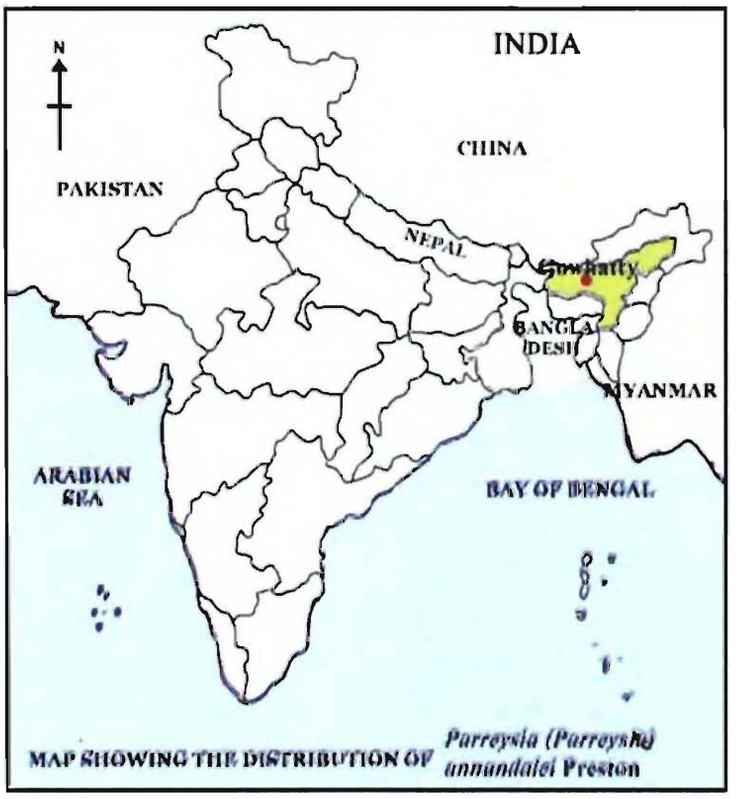
Type location : National Zoological Collection, ZSI, Regd. No. M 2490/1.

Latest name and Reference : *Parreysia (Parreysia) annandalei* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 176, figs. 444, 445.

Fig. 214. A. Exterior view of *Parreysia (Parreysia) annandalei* Preston (Type)

Fig. 214. B. Interior view of *Parreysia (Parreysia) annandalei* Preston (Type)

Diagnosis : Shell oval, convex, moderately solid, coarsely concentrically ribbed, covered with a thin, smooth, brownish-olivaceous periostracum; umbones rather small, not prominent; dorsal margin arched; ventral margin considerably rounded; anterior side slightly produced and rather sharply rounded; posterior side very bluntly subrostrate; cardinal teeth two in each valve, somewhat anteriorly situated, rather coarse and corrugated; lateral teeth strong, curved; anterior adductor scars rather small, very deeply excavated; posterior adductor scars also small, ovate, deeply impressed; interior of shell whitish, irridescent.



Distribution : India : Assam.

Parreysia (Parreysia) burmanus (Blanford, 1869)

1869. *Unio burmanus* Blanford, *Proc. zool. Soc. Lond.*, : 449. Type locality : Irawaddy river, near Bhamo.

Fig. 215. A. Exterior view of *Parreysia (Parreysia) burmanus* (Blanford)

Fig. 215. B. Interior view of *Parreysia (Parreysia) burmanus* (Blanford)

1900. *Parreysis burmanus* : Simpson, *Proc.U.S. natn. Mus.*, **22** : 845.

1912. *Parreysis burmanus* : Preston, *Rec. Indian Mus.*, **7** : 301.

1912. *Parreysia pernodulosa* : Preston, *Rec. Indian Mus.*, **7** : 300. Type locality : Zayleyman, Upper Burma.

1930. *Parreysia burmanus myitkyinae* : Prashad, *Rec.Indian Mus.*, **32** : 250, pl. 8, figs. 5-7. Type locality : Kamaing, in Myitkyina Dist.

1989. *Parreysia (Parreysia) burmanus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p.177, figs. 458, 459, 462, 463.

Type location : National Zoological Collection, ZSI Regd. No. M 2540/1 (Type); M 13021/2 (Paratype) of *M. burmanus myitkyinae*.

Latest name and Reference : *Parreysia (Parreysia) burmanus* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 87. *Zool. Surv. India.*

Diagnosis : Shell ovate, solid, dark brownish, sculpture with coarse corrugated ridges in anterior region and rather irregular nodulose in the rest; umbones large and distinct; anterior end sharply rounded, posterior end broad and gradually sloping, anterior dorsal margin rapidly sloping, ventral margin rounded;

Distribution : India : Manipur : Bishenpur.

Elsewhere : Myanmar : Bhamo, Zayleyman, Teinzo in the Mule stream, north east of Bhamo.

Parreysia (Parreysia) corbis (Benson, 1856)

1856. *Unio corbis* Benson, in Hanley's *Recent Bivalve Shells* : pl. 23, fig. 43. Type locality : Assam.

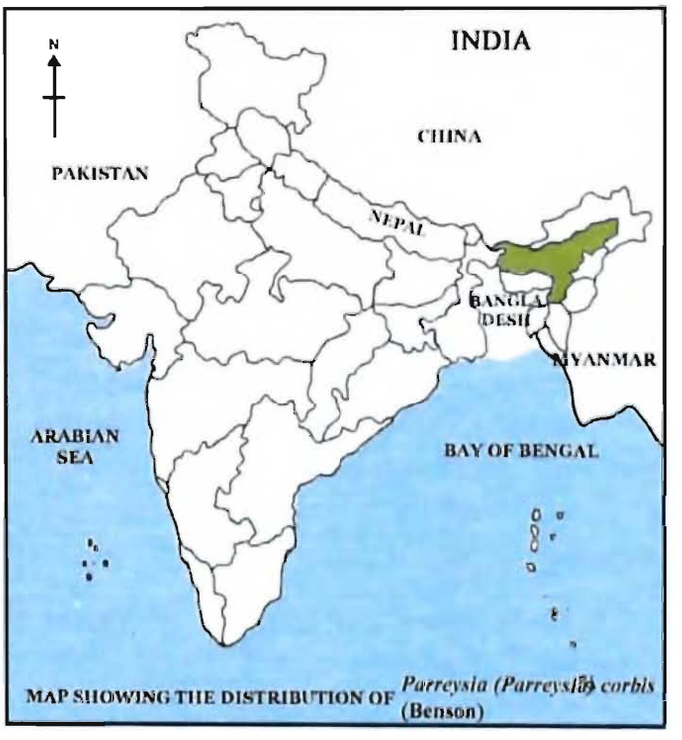
1900. *Parreysia corbis* : Simpson, *Proc. U. S. natn. Mus.*, **22** : 845.

Fig. 216. A. Exterior view of *Parreysia (Parreysia) corbis* (Benson)

Fig. 216. B. Interior view of *Parreysia (Parreysia) corbis* (Benson)

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) corbis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 178, figs. 454, 455.



Diagnosis : Shell oval, inequilateral, rather thin, subventricose, concentrically zoned with bluish green and ochraceous yellow, rather glossy, smooth, except at the umbones, which are adorned with longitudinally divergent slender corrugations, the hinder lines of which incline interiorwards, the front ones posteriorwards; a few similar wrinkles radiated subtransversely to the dorsal end of the concave anterior slope; ventral edge convex; front dorsal edge straight, a little elevated; extremities rounded, the front rather broad; nacre silvery; umbonal cavity simple; teeth laminar, compressed.

Distribution : India : Assam

Parreysia (Parreysia) corrugata (Mueller, 1774)

1774. *Mya corrugata* Mueller, *Verm. Terr.et. Fluv*, pt. 2 : 214, no. 398. Type locality : Rivers of Coromandel.

1900. *Parreysia corrugata* : Simpson, *Proc.U. S. natn. Mus.*, **22** : 841.

1912. *Parreysia corrugata* : Preston, *Rec. Indian Mus.*, **7** : 297.

Fig. 217. A. Exterior view of *Parreysia (Parreysia) corrugata* (Mueller)

Fig. 217. B. Interior view of *Parreysia (Parreysia) corrugata* (Mueller)

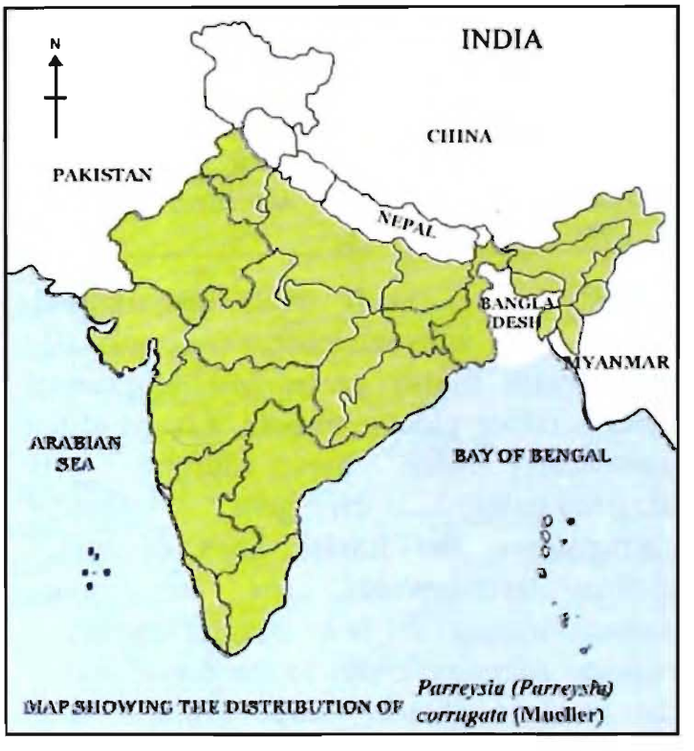
Type location : MNNH

Latest name and Reference : *Parreysia (Parreysia) corrugata* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 179, figs. 448, 449.

Diagnosis : Shell elliptic to oval, smooth, scarcely inequilateral; umbones prominent; lunule well marked; sculptured with somewhat radiating, oblique, linear ridges, ventral margin convex, cardinal teeth strong, not lamellar; green in colour.

Distribution : India : Widely distributed throughtout.

Elsewhere : Bangladesh : Sylhet; Sri Lanka; Myanmar.



Lomte (1971, 1972 & 1979), Nagabhushanam and Lomte (1971, 1972) studied the anatomy, histology, biochemistry and reproductive cycle of this species.

Parreysia (Parreysia) corrugata (Mueller) subsp. ***laevirostris*** (Benson, 1862)

1862. *Unio laevirostris* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 191.

1900. *Parreysia corrugata* var. *laevirostris* : Simpson, *Proc. U. S. natn. Mus.*, **22** : 842.

1912. *Parreysia corrugata* var. *laevirostris* : Preston, *Rec. Indian Mus.*, **7** : 297.

1989. *Parreysia (Parreysia) corrugata* sub sp. *laevirostris* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 179, figs., 452, 453.

Fig. 218. A. Exterior view of *Parreysia (Parreysia) corrugata* (Mueller) subsp. ***laevirostris*** (Benson, 1862)

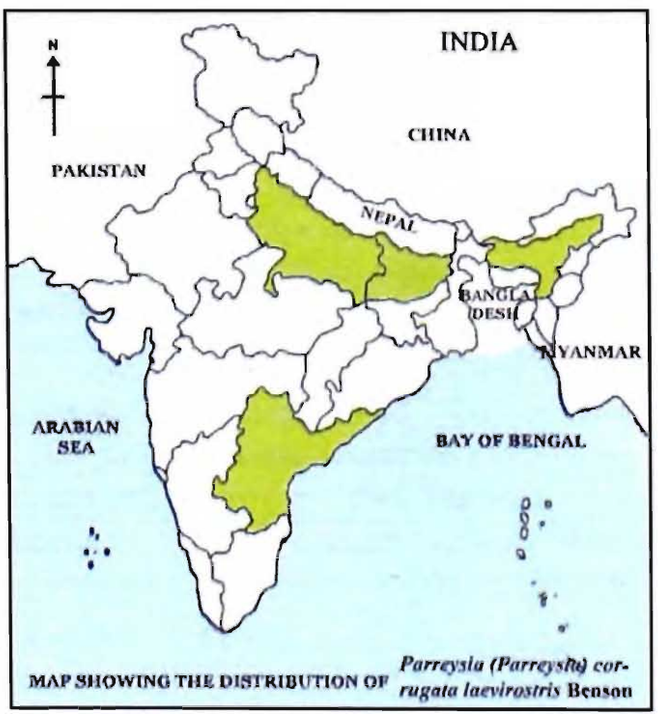
Fig. 218. B. Interior view of *Parreysia (Parreysia) corrugata* (Mueller) subsp. ***laevirostris*** (Benson, 1862)

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) corrugata sub sp. laevirostris* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 213. *Zool. Surv. India*:

Diagnosis : Shell elliptical, thick, nearly smooth, dorsal margin almost straight, posterior end broadly angulate, anterior end well rounded, cardinal teeth strong.

Distribution : India : Andhra Pradesh : Annantapur, Cuddapah, Kurnool, Srikakulum, Hyderabad; Assam, Bihar : Arrah; Uttar Pradesh : Chunar.



Elsewhere : Bangladesh : Chittagong Hills.

Remarks : The specimens from stream near Chunar (Uttar Pradesh) with Regd. No M 16945/2 of National Collection of ZSI were compared with Benson's Type.

Parreysia (Parreysia) corrugata (Mueller) subsp. ***nagpoorensis*** (Lea, 1859)

1859. *Unio nagpoorensis* Lea, *Proc. Acad. nat. Sci. Philad.*, **3** : 331. Type locality : Ambajori Tank, Nagpoor (=Nagpur), Maharashtra.

1859. *Unio wynegungaensis* : Lea, *Proc. Acad. nat. Sci. Philad.*, **3** : 331. Type locality : Wynegunga River, 30 miles east of Nagpur.

1900. *Parreysia corrugata* (Mueller) sub var. *nagpoorensis* : Simpson, *Proc.U. S. natn. Mus.*, **22** : 842.

1989. *Parreysia (Parreysia) corrugata* (Mueller) sub sp.*nagpoorensis* : Subba Rao, *Handbook of Freshwater Molluscs of India.* p. 180, figs. 450, 451, 482, 483.

Fig. 219. A. Exterior view of *Parreysia (Parreysia) corrugata* (Mueller) subsp. ***nagpoorensis*** (Lea)

Fig. 219. B. Interior view of *Parreysia (Parreysia) corrugata* (Mueller) subsp. ***nagpoorensis*** (Lea)

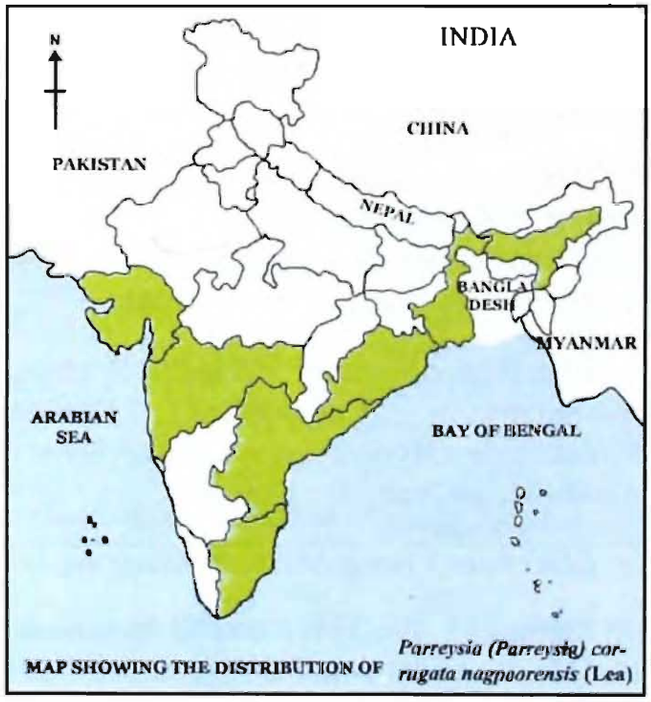
Type location : ANSP (Holotype), USNM (Holotype of *U. wynegungaensis*).

Latest name and Reference : *Parreysia (Parreysia) corrugata nagpoorensis* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 214. *Zool. Surv. India.*

Diagnosis : Shell oval, thick, greenish, sculptured with zigzag markings arranged in rows, concentrated at umbonal region; dorsal margin evenly sloping, anteriorly rounded, posterior end obtusely pointed.

Distribution : India : Andhra Pradesh : Annantapur, Kurnool, Nellore, Gudur, Godavari River; Assam, Gujarat, Maharashtra, Orissa, Tamil Nadu, West Bengal.

Elsewhere : Bangladesh.



MAP SHOWING THE DISTRIBUTION OF *Parreysia (Parreysia) corrugata nagpoorensis* (Lea)

Parreysia (Parreysia) favidens (Benson, 1862)

1862. *Unio favidens* Benson, *Ann. Mag. Nat. Hist.*, **(3) 10** : 188. Type locality : "Bhitoura on the Ganges between Cawnpore (Kanpur) and Allahabad."

1900. *Parreysia favidens* : Simpson, *Proc.U. S. natn. Mus.*, **22** : 842.

1912. *Parreysia favidens* : Preston, *Rec. Indian Mus.*, **7** : 299.

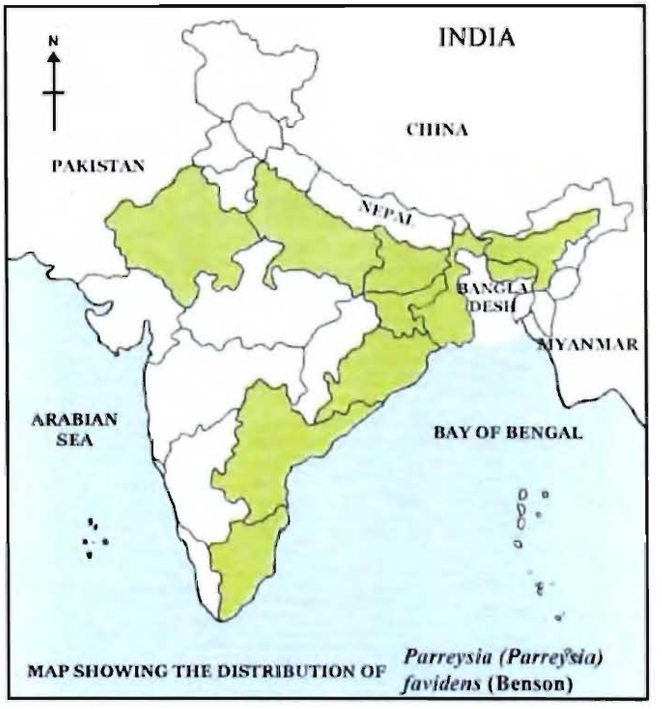
Fig. 220. A. Exterior view of *Parreysia (Parreysia) favidens* (Benson)

Fig. 220. B. Interior view of *Parreysia (Parreysia) favidens* (Benson)

Type location : National History Museum, London.

Latest name and Reference : *Parreysia favidens* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 180, figs. 466, 467,484, 485.

Diagnosis : Shell thick and heavy, inflated, with strong zig-zag ribs on beak, unequilateral and angulate both on anterior and posterior margins, cardinal teeth strong and broad.



MAP SHOWING THE DISTRIBUTION OF *Parreysia (Parreysia) favidens* (Benson)

Distribution : India : Andhra Pradesh: Kurnool; Assam, Bihar, Jharkhand, Maharashtra, Meghalaya : Garo hills (West), Khasi hills (East & West); Orissa, Rajasthan, Tamil Nadu : Chennai; Uttar Pradesh, West Bengal.

Elsewhere : Bangladesh: Dacca, Sylhet; Pakistan.

Parreysia (Parreysia) favidens var. *assamensis* Preston, 1912

1912. *Parreysia favidens* var. *assamensis* Preston, *Rec. Indian Mus.*, **7** : 299. Type locality : Digong, Assam.

1989. *Parreysia (Parreysia) favidens* subsp. *assamensis* : Subba Roa, *Handbook Freshwater Molluscs of India*, p. 181, figs. 468, 469.

Fig. 221. A. Exterior view of *Parreysia (Parreysia) favidens* var. *assamensis* Preston

Fig. 221. B. Interior view of *Parreysia (Parreysia) favidens* var. *assamensis* Preston

Fig. 222. A. Exterior view of *Parreysia (Parreysia) favidens* var. *assamensis* Preston (Holotype)

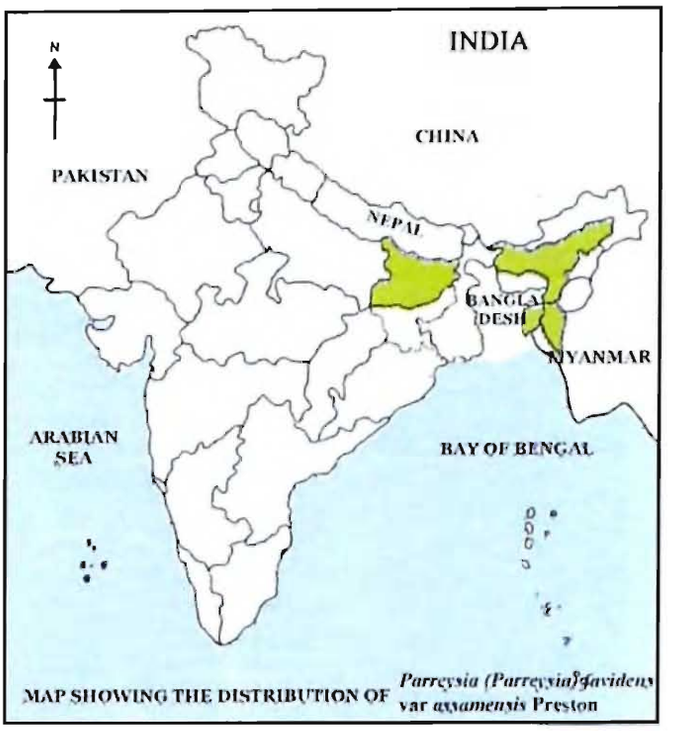
Fig. 222. B. Interior view of *Parreysia (Parreysia)* var. *assamensis* Preston (Holotype)

Type location : National Zoological Collection, ZSI, Regd. No. M 2479/1 (Holotype), M 9996/2 (Cotypes).

Latest name and Reference : *Parreysia (Parreysia) favidens* sub sp. *assamensis* : Mookherjee, Thakur, Mitra and Barua, 2000, *Fauna of Tripura, State Fauna Series*, **7**, p. 337, *Zool. Surv. India.*

Diagnosis : Shell more convex that typical form, dorsal margin rather less posteriorly angled, anterior side is more rounded and posterior slightly more nasute.

Distribution : India : Assam: Digong; Bihar: Arrah; Mizoram, Tripura.



Parreysia (Parreysia) favidens var ***chrysis*** (Benson, 1862)

1862. *Parreysia favidens* var *chrysis* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 189. Type locality : Dojora River, Kareily Ghat near Bareily.

1876. *Parreysia favidens* var *chrysis* : Hanley and Theobald, *Conch Indica* : 19, pl. 41, fig. 3.

Fig. 223. A. Exterior view of *Parreysia (Parreysia) favidens* var *chrysis* (Benson)

Fig. 223. B. Interior view of *Parreysia (Parreysia) favidens* var *chrysis* (Benson)

Fig. 224. A. Exterior view of *Parreysia (Parreysia) favidens* var *chrysis* (Benson) (Type)

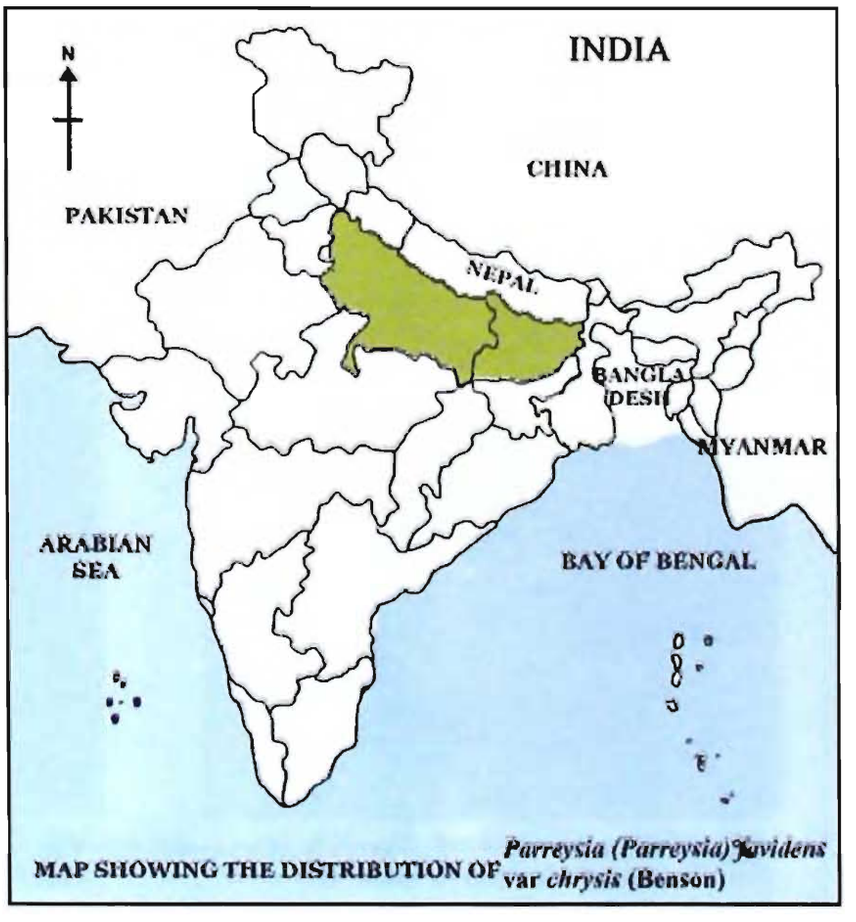
Fig. 224. B. Interior view of *Parreysia (Parreysia) favidens* var *chrysis* (Benson) (Type)

Type location : National Zoological Collection, ZSI, Regd. No. M 2459/1.

Latest name and Reference : *Parreysia (Parreysia) favidens* sub sp. *chrysis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 181.

Diagnosis : Shell longer and less broad; epidermis green with yellowish band; umbonal rugae strong and extended; cardinal teeth narrower; nacre salmon-tinted.

Distribution : India : Bihar : Patna; Uttar Pradesh : Bareily.



Parreysia (Parreysia) favidens subsp. ***deltae*** (Benson, 1862)

1862. *Parreysia favidens* var. *deltae* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 189. Type locality : Jellinghy river, West Bengal.

1876. *Parreysia favidens* var. *deltae* : Hanley and Theobald, *Conch Indica* : 19, pl. 62, fig. 2.

1989. *Parreysia (Parreysia) favidens* sub sp. *deltae* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 181, figs. 470, 471.

Fig. 225. A. Dorsal view of *Parreysia (Parreysia) favidens* subsp. *deltae* (Benson)

Fig. 225. B. Ventral view of *Parreysia (Parreysia) favidens* subsp. *deltae* (Benson)

Fig. 226. A. Exterior view of *Parreysia (Parreysia) favidens* subsp. *deltae* (Benson) (Type)

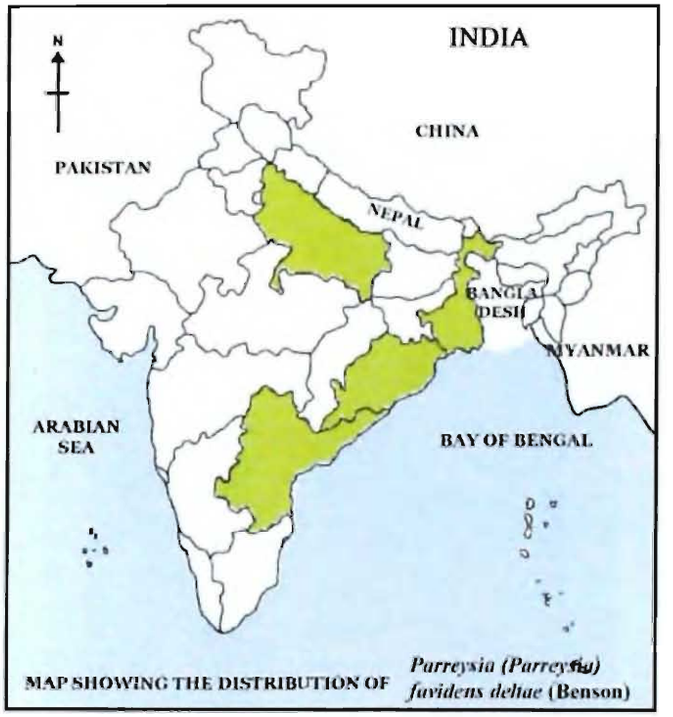
Fig. 226. B. Interior view of *Parreysia (Parreysia) favidens* subsp. *deltae* (Benson) (Type)

Type location : National Zoological Collection, ZSI, Regd. No. M 16944/2.

Latest name and Reference : *Parreysia (Parreysia) favidens deltae* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 214. *Zool. Surv. India*:

Diagnosis : Shell less elongate, periostracum olive green and yellow, posterior margin subangulate; lunule broad; umbonal region strongly sculptured; cardinal teeth narrower.

Distribution : India : Andhra Pradesh: Khammam, Srikakulum; Orissa, Uttar Pradesh, West Bengal : Kolkata, Hugli, 24 Paraganas (North).



MAP SHOWING THE DISTRIBUTION OF *Parreysia (Parreysia) favidens deltae* (Benson)

Parreysia (Parreysia) favidens var. ***marcens*** Benson

1862. *Unio favidens* var. *marcens* Benson, *Ann. Mag. nat. Hist.*, (3) **10**: 188.

Fig. 227. A. Exterior view of *Parreysia (Parreysia) favidens* var. *marcens* Benson

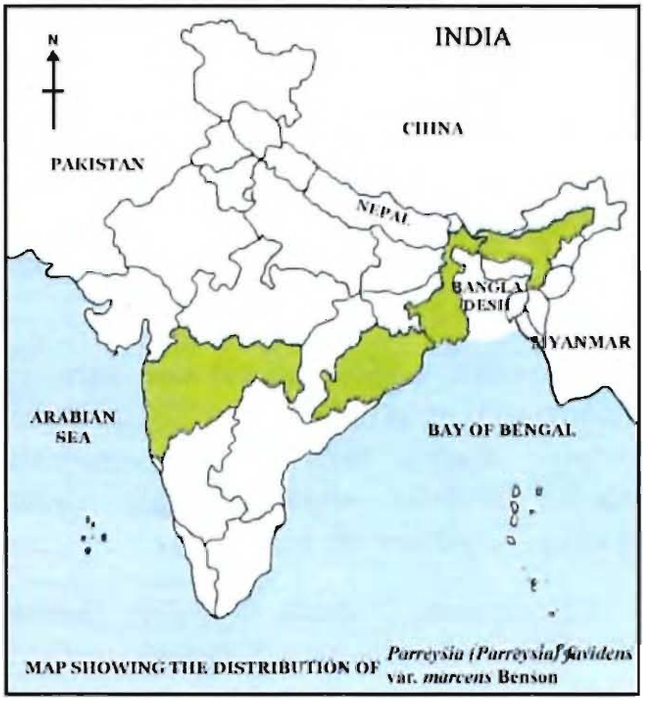
Fig. 227. B. Interior view of *Parreysia (Parreysia) favidens* var. *marcens* Benson

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) favidens marcens* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series,* **5**(Part-5), p. 215. *Zool. Surv. India,*

Diagnosis : Shell larger, more elongate, dark brown, umbonal region weakly sculptured, posterior margin broadly rounded.

Distribution : India : Andhra Pradesh : Khammam, Srikakulum, Assam, Maharashtra, West Bengal : Bardhaman, Kolkata.



MAP SHOWING THE DISTRIBUTION OF *Parreysia (Parreysia) favidens* var. *marcens* Benson

Parreysia (Parreysia) favidens plagiosoma (Benson, 1862)

1862. *Unio plagiosoma* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 19.

Fig. 228. A. Exterior view of *Parreysia (Parreysia) favidens plagiosoma* (Benson)

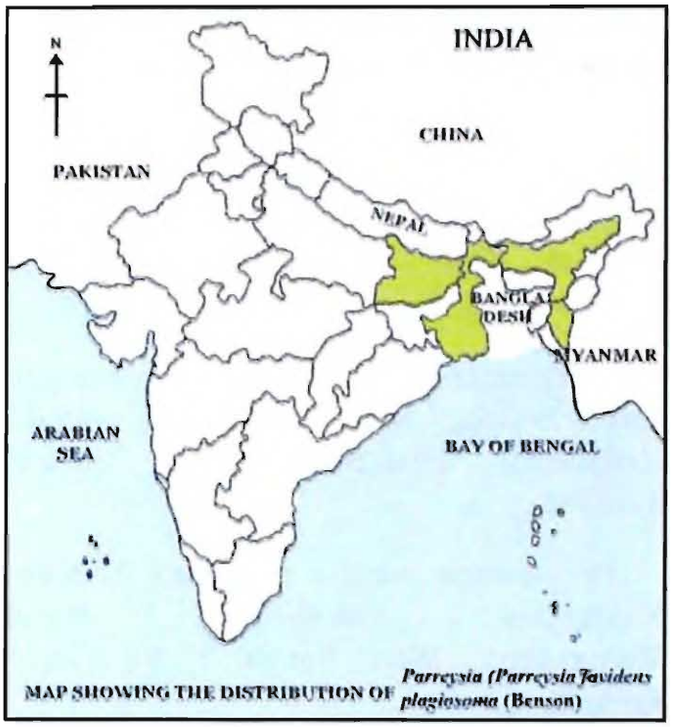
Fig. 228. B. Interior view of *Parreysia (Parreysia) favidens plagiosoma* (Benson)

Type location : National History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) favidens plagiosoma* : Mitra and Dey, 1992, *Fauna of West Bengal, State Fauna Series,* **3**(Part-9), p. 31. *Zool. Surv. India,*

Diagnosis : Shell thinner and narrower than the typical form, ovately, trigonal, anterior margin well rounded, posterior margin broader, dorsal margin evenly sloping; sculpture on beak only.

Distribution : India : Bihar, Assam, Mizoram, West Bengal : Birbhum.



Parreysia (Parreysia) favidens subsp. ***viridula*** (Benson, 1862)

1862. *Parreysia favidens* var. *viridula* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 189. Type locality : Jheel between Hameerpore & Someerpore, Bundelkhand.

Fig. 229. A. Exterior view of *Parreysia (Parreysia) favidens* subsp. *viridula* (Benson)

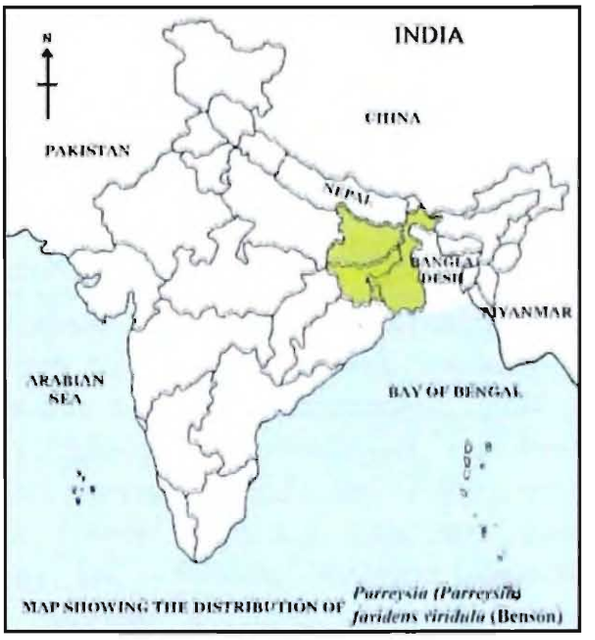
Fig. 229. B. Interior view of *Parreysia (Parreysia) favidens* subsp. *viridula* (Benson)

Type location : National History Museum, London.

Latest name and Reference : *Parreysia favidens* sub sp. *viridula* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 182, figs. 474, 475.

Diagnosis : Shell compressed; cardinal teeth broad; nacre bluish white; umbonal rugae strong and extended.

Distribution : India : Bihar : Gandak, Patna; Jharkhand : Dumka; West Bengal : Bardhaman, Puruliya.



Parreysia (Parreysia) gowhattensis (Theobald, 1873)

1873. *Unio gowhattensis* Theobald, *J. Asiat. Soc. Beng.*, **42(2)** : 208, pl. 17, fig. 4. Type locality : Gowhatty.

1900. *Parreysia gowhattensis* : Simpson, *Proc.U. S. natn. Mus.*, **22** : 845.

1912. *Parreysia gowhattensis* : Preston, *Rec. Indian Mus.*, **7** : 301.

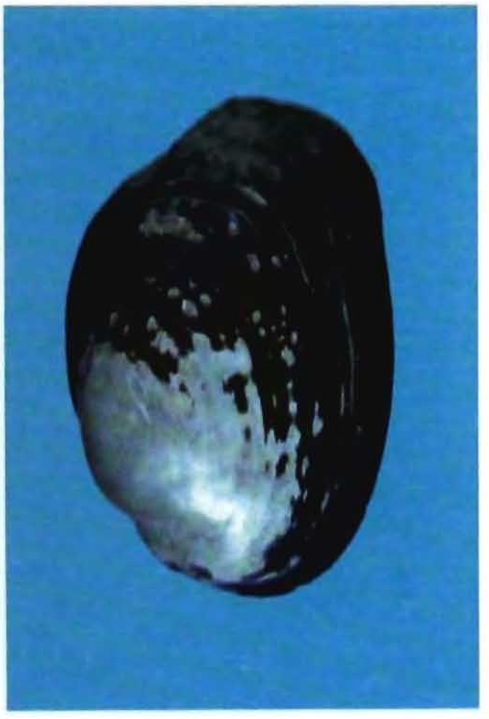


Fig. 230. A. Exterior view of *Parreysia (Parreysia) gowhattensis* (Theobald)

Fig. 230. B. Interior view of *Parreysia (Parreysia) gowhattensis* (Theobald)

Type location : National History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) gowhattensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 183, figs. 498, 499.

Diagnosis : Shell thick, inequilateral, quadrately ovate, periostracum brownish-yellow, concentrically striated and rugose; umbones prominent but eroded; anterior side curved and short, posterior side long and truncate; posterior dorsal margin straight between umbones and suddenly sloping on the posterior margin; ventral margin curved and indented on the posterior side.

Distribution : India : Assam.

Parreysia (Parreysia) rajahensis (Lea, 1841)

1841. *Unio rajahensis* Lea, *Proc. Am. Phil. Soc.*, **2** : 30. Type locality : Rajah's tank, Calcutta.

1900. *Parreysia rajahensis* : Simpson, *Proc.U. S. natn. Mus.*, **22** : 844.

1912. *Parreysia rajahensis* : Preston, *Rec. Indian Mus.*, **7** : 301.

Fig. 231. A. Exterior view of *Parreysia (Parreysia) rajahensis* (Lea)

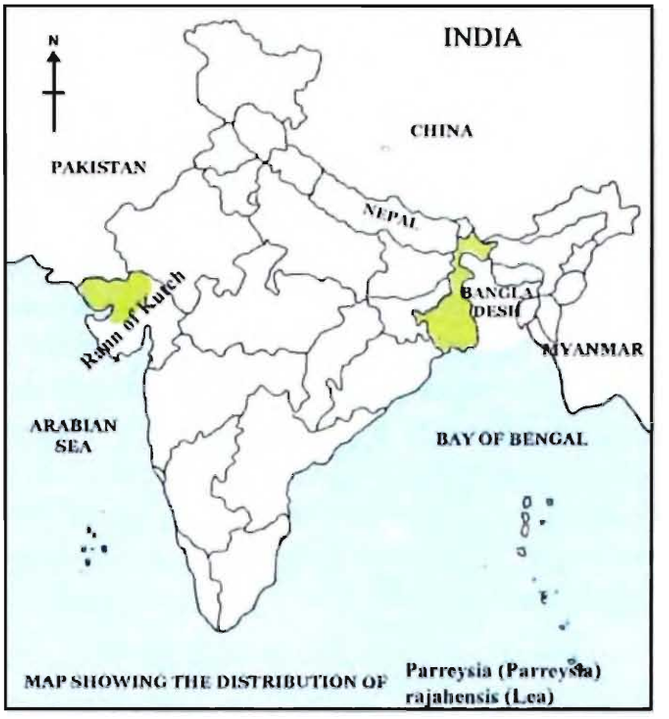
Fig. 231. B. Interior view of *Parreysia (Parreysia) rajahensis* (Lea)

Type location : USNM

Latest name and Reference : *Parreysia (Parreysia) rajahensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 185, figs. 492, 493.

Diagnosis : Shell triangular, inflated, posteriorly angulated; umbo elevated, pointed and almost in the middle; anterior margin rounded; ventral margin convex; sculptured with prominent growth lines; greenish brown externally with brightly nacreous internally.

Distribution : India : Narmada River, Rann of Kutch, Sepree and Sahib Ganj; West Bengal : Kolkata.



Parreysia (Parreysia) sikkimensis (Lea, 1859)

1859. *Unio sikkimensis* Lea, *Proc. Acad. nat. sci. Philad.*, **3** : 151. Type locality : Sikkim

1900. *Unio sikkimensis* : Simpson, *Proc. U. S. natn. Mus.*, **22** : 845.

1912. *Parreysia sikkimensis* : Preston, *Rec. Indian Mus.*, **7** : 301.

Fig. 232. A. Exterior view of *Parreysia (Parreysia) sikkimensis* (Lea)

Fig. 232. B. Interior view of *Parreysia (Parreysia) sikkimensis* (Lea)

Type location : USNM.

Latest name and Reference : *Parreysia (Parreysia) sikkimensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 185, figs. 488, 489.

Diagnosis : Shell more convex proportionate to its size, short, broad and ovate; anterior end rounded; posterior gradually tapering; ventral margin convex; umbo anterior, slightly elevated; anterior adductor muscle scar deep and oval; posterior adductor muscle scar semilunar; brownish yellow externally with bright nacreous internally.

Distribution : India : Arunachal Pradesh : Dihing; Assam : Cachar; Sibsagar; Mizoram, Sikkim : Namchik; Uttar Pradesh, West Bengal : Siliguri.

Remarks : Blanford (1866) expressed doubt regarding the type locality of this species.

Parreysia (Parreysia) smaragdites (Benson, 1862)

1862. *Unio smaragdites* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 190. Type locality : "Berhampooter"= (Brahmaputra river), Assam.

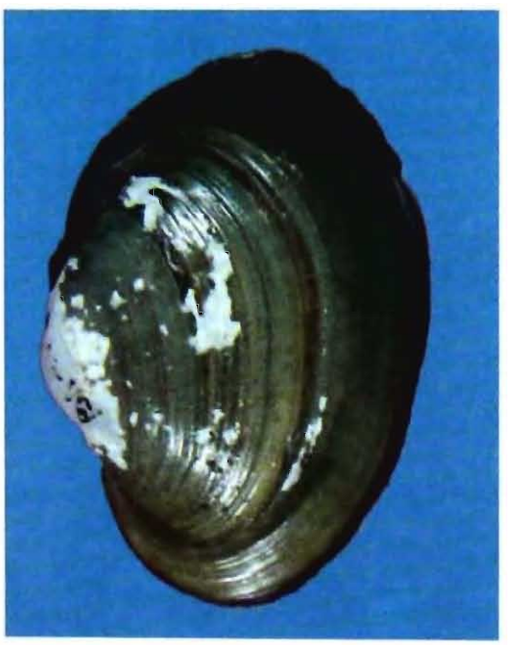


Fig. 233. A. Exterior view of *Parreysia (Parreysia) smaragdites* (Benson)

Fig. 233. B. Interior view of *Parreysia (Parreysia) smaragdites* (Benson)

1900. *Parreysiasmaragdites* : Simpson, *Proc. U. S. natn. Mus.*, **22** : 843.

1922. *Parreysia smaragdites* : Prashad, *Rec. Indian Mus.*, **24** : 102.

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) smaragdites* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 185, figs. 504, 505.

Diagnosis : Shell medium upto 25 mm with narrow anterior and broad posterior end; umbo anterior; ventral margin convex; lunule prominent and almost equal in two valves; green interspersed with lemon yellow externally and white internally; adductor muscles scars moderate.

Distribution : India : Assam.

Elsewhere : Upper Myanmar.

Remarks : The specimens collected from Brahmaputra river, Assam having Regd. No. M 16946/2 were compared with Benson's type present in National Zoological Collection, ZSI.

Parreysia (Parreysia) triembolus (Benson, 1855)

1855. *Unio triembolus* Benson, *J. Asiat. Soc. Beng.*, **35** : 44. Type locality : Nerbudda (=Narmada).

Fig. 234. A. Exterior view of *Parreysia (Parreysia) triembolus* (Benson)

Fig. 234. B. Interior view of *Parreysia (Parreysia) triembolus* (Benson)

1876. *Unio triembolus* : Hanley and Theobald, *Conch Indica,* : 43, pl. 107, fig. 2.

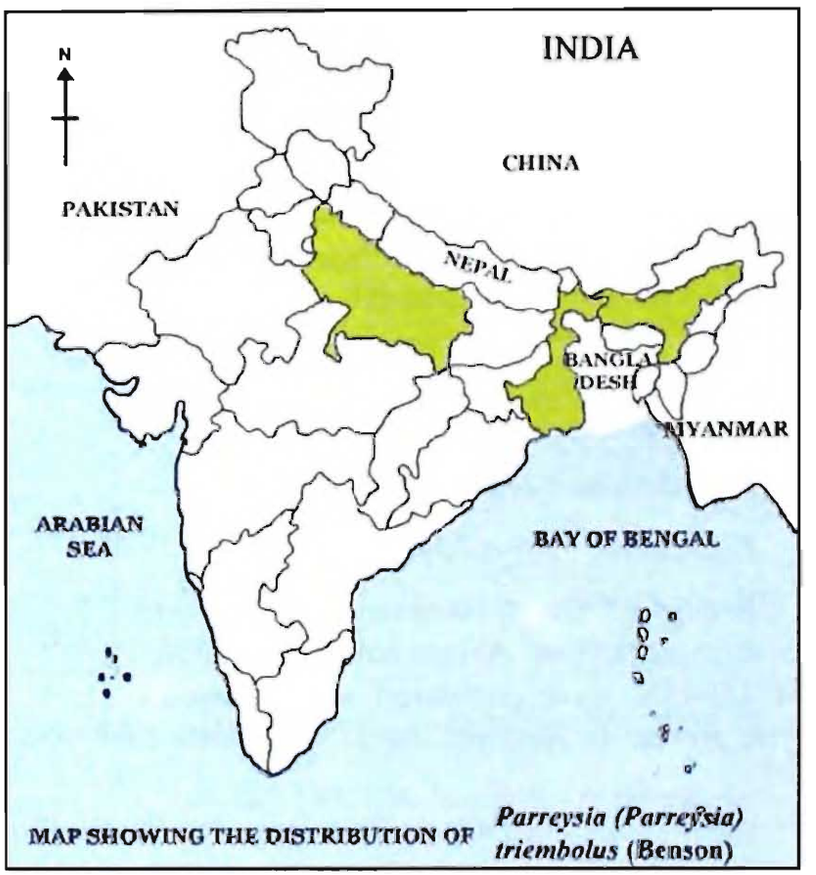
1915. *Parreysia tavoyensis* var. *triembolus* : Preston, *Fauna Brit India Mollusca,* (Freshwater Gastropoda and Pelecypoda), p. 167.

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Parreysia) triembolus* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India, p.* 186, figs. 506, 507.

Diagnosis : Shell thick with large teeth. A massive species, which inhabits the Nerbuddha, and the shells of which are found fossil associated with the bones of extinct mammalia in the gravels of the river valley, may be a variety of this species.

Distribution : India : Assam : Cachar, Barack river, Silchar; Uttar Pradesh : Ramganga near Moradabad; West Bengal : Kolkata.



Subgenus ***Radiatula*** Simpson, 1900

1900. *Radiatula* Simpson, *Proc. U.S. natn. Mus.,* **22** : Type species : *Unio crispisulcatus* Benson, 1862; original designation.

Shell triangularly oval; umbo little inflated, entire surface of the disc covered with radiating or zig-zag or divaricate ridges separated into nodules by concentric sulcations.

Animal carry the glochidium larvae in all four marsupial gills. It is similar with *Parreysia* by anatomical features but differs from it by sculpture, beak and structure of glochidium larvae.

Prashad (1918) proposed genus *Indonaia* which include all the Indian species which formerly grouped along with Japanese and African species under genus *Nodularia* (Preston, 1915). Haas (1969) included *Radiatula* as a separate subgenus under *Parreysia* and synonomised *Indonaia* with it.

Key to tha species

1. Umbonal region without sculpture ..... (2)

– Umbonal region with sculpture ..... (5)

2. Ventral margin convex ..... (4)

– Ventral margin straight or slightly depressed in mid region ..... (3)

3. Posterior end obtuse, umbo more pronounced ..... *P. (R.) pachysoma* (Benson)

– Posterior end broad, umbo not much pronounced ..... *P. (R.) theobaldi* (Preston)

4. Umbo nearly $^{1}/_{3}^{rd}$ of the shell length ..... *P. (R.) nuttalliana* (Lea)

– Umbo more than $^{1}/_{3}^{rd}$ of the shell length ..... *P. (R.) olivaria* (Lea)

5. Posterior end pointed, a prominent ridge on posterior region ..... *P. (R.) khadakvaslaensis* (Ray)

– Posterior end not pointed, shell without prominent ridge on posterior region ..... (6)

6. Umbo anterior (less than $^{1}/_{4}^{th}$ of the total length) ..... (7)

– Umbo anterior (more than $^{1}/_{3}^{rd}$ of the total length) ..... (9)

7. Ventral margin straight or slightly convex ..... *P. (R.) caerulea* (Lea)

– Ventral margin depressed ..... (8)

8. Corrugated sculpture almost throughout the body ..... *P. (R.) cylindrica* Annandale and Prashad

– Corrugated sculpture only in umbonal region ..... *P. (R.) shurtleffiana* (Lea)

9. Posterior end wide ..... (10)

– Posterior end narrow ..... (11)

10. Sculpture only on umbonal region ..... *P. (R.) bonneaudi* (Eydoux)

– Sculpture well developed on dorsal region ..... *P. (R.) lima* (Simpson)

11. Umbo indistinct, not at all raised ..... *P. (R.) andersoniana* (Nevill)

– Umbo distinct, raised ..... *P. (R.) occata* (Lea)

Parreysia (Radiatula) andersoniana (Nevill, 1877)

1877. *Unio andersonianus* Nevill, *J. Asiat. Soc. Beng.*, **46** : 40. Type locality : Myadong, Upper Myanmar.

1915. *Nodularia (Nodularia) andersoniana* : Preston, *Fauna British India Mollusca*, (Freshwater Gastropoda and Pelecypoda), p. 143.

Fig. 235. A. Exterior view of *Parreysia (Radiatula) andersoniana* (Nevill)

Fig. 235. B. Interior view of *Parreysia (Radiatula) andersoniana* (Nevill)

Type location : National Zoological Collection, ZSI, Regd. No. M 5192/2.

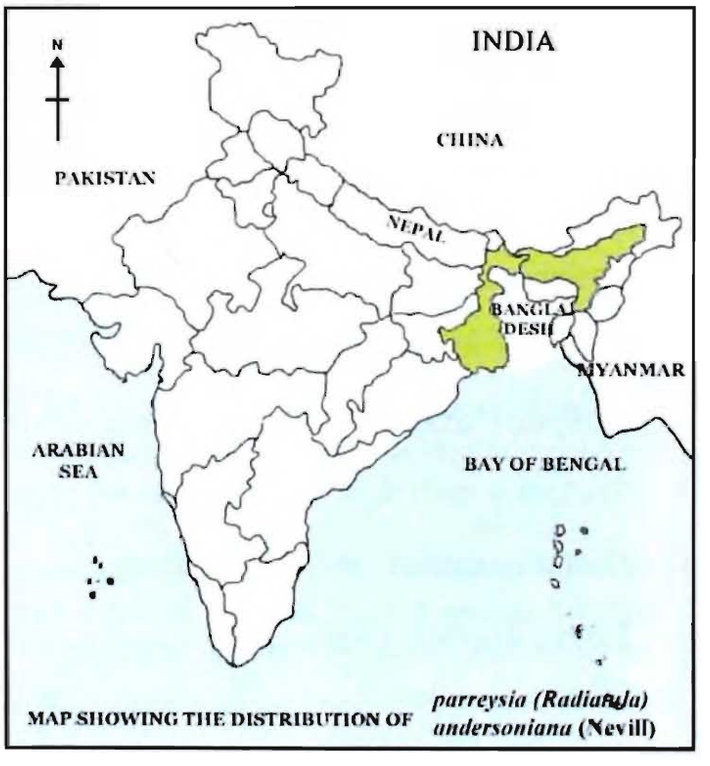
Latest name and Reference : *Parreysia (Radiatula) andersoniana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 187, figs. 508, 509.

Diagnosis : Shell smaller, thin, umbo indistinct, not at all raised; sculpture strong on umbonal region, pallial line prominent.

Remarks : In general shape it resembles *P. caerulea* but its strong sculpture on umbonal region and greenish tumid shell distinguish it from other species.

Distribution : India : Assam : Silchar; West Bengal : Siliguri;

Elsewhere : Myanmar: Myadong



Parreysia (Radiatula) bonneaudi (Eydoux, 1838)

1838. *Unio bonneaudi* Eydoux, *Mag.de. Zool. cl.*, **5** : 101, pl. 119, figs. 1, 1a.

1900. *Nodularia (N.) bonneaudi* : Simpson, *Proc. U. S. natn. Mus.*, **22** : 813.

1921. *Indonaia bonneaudi* : Prashad, *Rec. Indian Mus.*, **22** : 603.

1989. *Parreysia (Radiatula) bonneaudi* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 187, figs. 510, 511.

Fig. 236. A. Exterior view of *Parreysia (Radiatula) bonneaudi* (Eydoux)

Fig. 236. B. Interior view of *Parreysia (Radiatula) bonneaudi* (Eydoux)

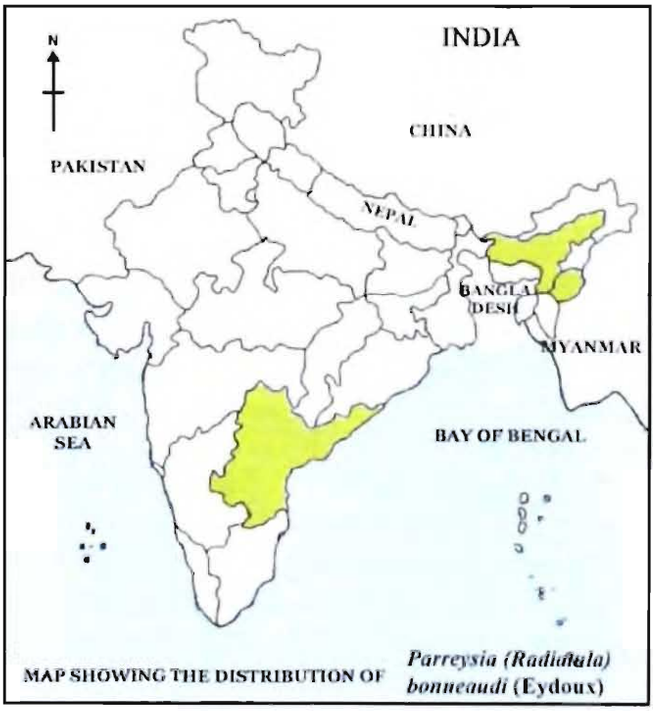
Type location : Not known.

Latest name and Reference : *Parreysia (Radiatula) bonneaudi* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 216. *Zool. Surv. India.*

Diagnosis : Shell variable in shape and colour, thick, elongate, tumid with fine sculpture on umbonal region and with vertical marking on the rest of the surface; umbo central; dorsal margin convex, anterior end short, rounded, posterior end long and sloping.

Distribution : India : Andhra Pradesh : Khammam, Srikakulum; Assam, Manipur.

Elsewhere : Myanmar.



MAP SHOWING THE DISTRIBUTION OF *Parreysia (Radiatula) bonneaudi* (Eydoux)

Parreysia (Radiatula) caerulea (Lea, 1831)

1831. *Unio caerulea* Lea, *Trans. Amer. Phil. Soc.*, **4** : 95, pl. 13, fig. 25. Type locality : "Hooghly river, 100 miles above Calcutta."

1915. *Nodularia (Nodularia) caerulea* : Preston, *Fauna Brit India Mollusca,* (Freshwater Gastropoda and Pelecypoda), p. 136.

1989. *Parreysia (Radiatula) caerulea* : Subba Rao, *Handbook of Freshwater Molluscs of India,* p. 188, figs. 516, 517.

Fig. 237. A. Exterior view of *Parreysia (Radiatula) caerulea* (Lea)

Fig. 237. B. Interior view of *Parreysia (Radiatula) caerulea* (Lea)

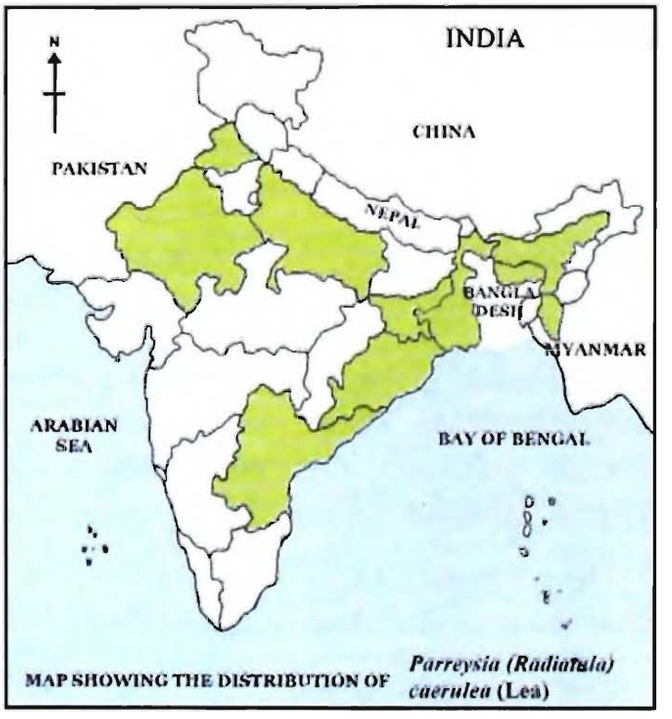
Type location : USNM (Holotype), ANSP (Paratype).

Latest name and Reference : *Parreysia (Radiatula) caerulea* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 216. *Zool. Surv. India.*

Diagnosis : Shell elongate, variable in shape, sculpture restricted to the upper half of the valves in the adult whereas in the young one the whole shell surface sculptured, posterior umbonal carina very distinct.

Distribution : India : Andhra Pradesh : Nalgonda, Prakasam, Godavari; Assam, Jharkhand, Meghalaya : Garo hills (West), Khasi hills (East); Mizoram, Orissa, Punjab, Rajasthan, Uttar Pradesh, West Bengal.

Elsewhere : Bangladesh; Myanmar; Nepal; Pakistan : Sind



MAP SHOWING THE DISTRIBUTION OF *Parreysia (Radiatula) caerulea* (Lea)

Parreysia (Radiatula) caerulea var. ***gaudichaudi*** (Eydoux, 1838)

1838. *Unio gaudichaudi* Eydoux, *Mag. de. Zool.*, **5** : 10, pl. 118, fig. 3.

1915. *Nodularia (Nodularia) caerulea* var. *gaudichaudi* : Preston, *Fauna. Brit India Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 137.

1989. *Parreysia (Radiatula) caerulea* subsp. *gaudichaudi* : Subba Rao, *Handboom Freshwater Molluscs of India*, p. 188, figs. 158, 159.

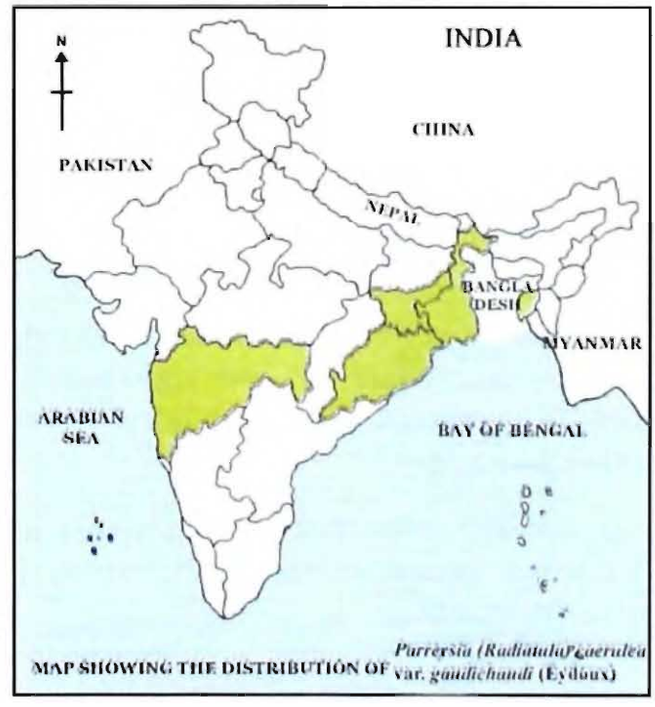
Fig. 238. A. Exterior view of *Parreysia (Radiatula) caerulea* var. ***gaudichaudi*** (Eydoux)

Fig. 238. B. Interior view of *Parreysia (Radiatula) caerulea* var. ***gaudichaudi*** (Eydoux)

Type location : Not known.

Latest name and Reference- Parreysia (Radiatula) caerulea sub sp. *gaudichaudi* : Mookherjee, Thakur, Mitra and Barua, 2000, *Fauna of Tripura, State Fauna Series*, **7**, p. 339. *Zool. Surv. India.*

Diagnosis : Shell oval, transverse, inequilateral; umbones not prominent, slightly roughened, covered with a periostracum; the anterior side slightly swollen; texture of shell thin, finely or irregularly striate and covered with a dirty brown or yellowish periostracum; interior of shell nacreous, of a pinkish-violet shade; hinge very narrow and nearly straight, a single, rough and projecting cardinal tooth appearing on the right valve and two oblique



and unequal caedinal teeth in the left valve; lateral teeth very thin, smooth, obliquely truncate at the posterior end, the plates of the opposite valve, between which it fits, of nearly equal size.

Distribution : India : Jharkhand: Santhal Paragana (Gumani River near Kusma); Maharashtra, Orissa, Tripura, Rivers of West Bengal;

Elsewhere : Bangladesh : Dacca.

Parreysia (Radiatula) cylindrica Annandale and Prashad, 1919

1919. *Parreysia cylindrica* Annandale and Prashad, *Rec. Indian Mus.*, **16**:150, pl. 4, figs. 6,7. Type locality : Yenna River, Upper Krishna Watershed, at Medha, Maharashtra.

Fig. 239. A. Exterior view of *Parreysia (Radiatula) cylindrica* Annandale and Prashad

Fig. 239. B. Interior view of *Parreysia (Radiatula) cylindrica* Annandale and Prashad

Type location : National Zoological Collection, ZSI Regd No. M 11398/2 (Syntypes).

Latest name an Reference : *Parreysia (Parreysia) cylindrica* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 180, figs. 460, 461.

Diagnosis : Shell thick, dorsal margin straight and anterior margin broadly rounded, umbonal region sculptured with corrugated ridges.

It closely resembles *P. favidens* in all characters except in the shell, which is more elongated.

Distribution : India : Maharashtra.

Parreysia (Radiatula) involuta (Benson, 1856)

1856. *Unio involutus* Benson, in Hanley's *Recent Bivalve shells*, : 385, pl. 23, fig. 19. Type locality : Assam.

1915. *Nodularia (Nodularia) involuta* : Preston, *Fauna Brit India Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 146.

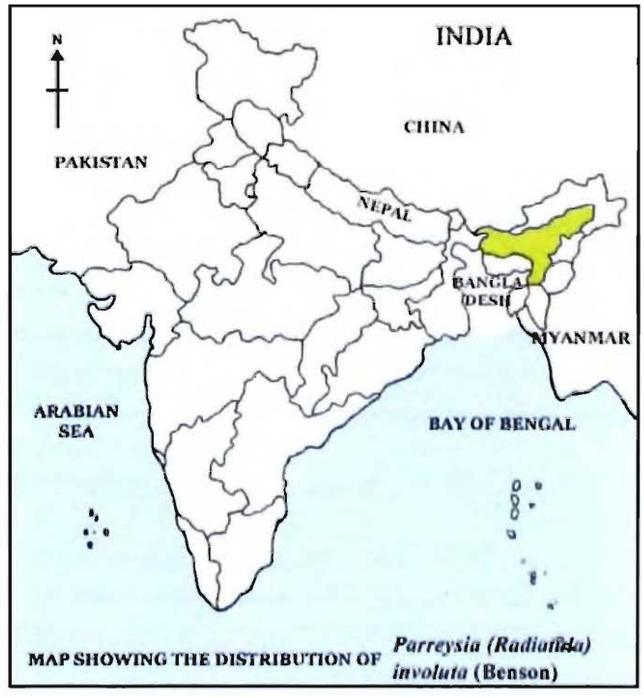
Fig. 240. A. Exterior view of *Parreysia (Radiatula) involuta* (Benson)

Fig. 240. B. Interior view of *Parreysia (Radiatula) involuta* (Benson)

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Radiatula) involuta* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 189.

Diagnosis : Shell peaked ovate, inequilateral, thin, polished, compressed in front, swollen in the umbonal region, pale green, obscurely subradiated ventrally with ochre yellow, rather tinged with blue dorsally, marked with 2 or 3 dark green lines on the anterior slope, partially marked with some close and regularly shallow groove-like posterior wrinkles, elsewhere smooth, ventral edge strongly arcuated and



much rising behind, less curved yet almost equally rising in front; anterior side tapering to a blunt subcentral peak, no umbonal redge; hinder dorsal edge nearly straight, scarcely sloping; umbones swollen, prominent, with a few longitudinal corrugations; beaks incurved; nacre silvery; umbonal cavity ample; lateral teeth large, laminar, raised, the shorter one very elevated at its extremity.

Distribution : India : Assam.

Elsewhere : Bangladesh.

Parreysia (Radiatula) khadakvaslaensis (Ray, 1966)

1966. *Indonaia khadakvaslaensis* Ray, *J. Conch. Paris*, **105**(4) : 226. Type locality : Khadakvasla dam, Pune, Maharashtra.

Fig. 241. A. Exterior view of *Parreysia (Radiatula) khadakvaslaensis* (Ray) (Holotype)

Fig. 241. B. Interior view of *Parreysia (Radiatula) khadakvaslaensis* (Ray) (Holotype)

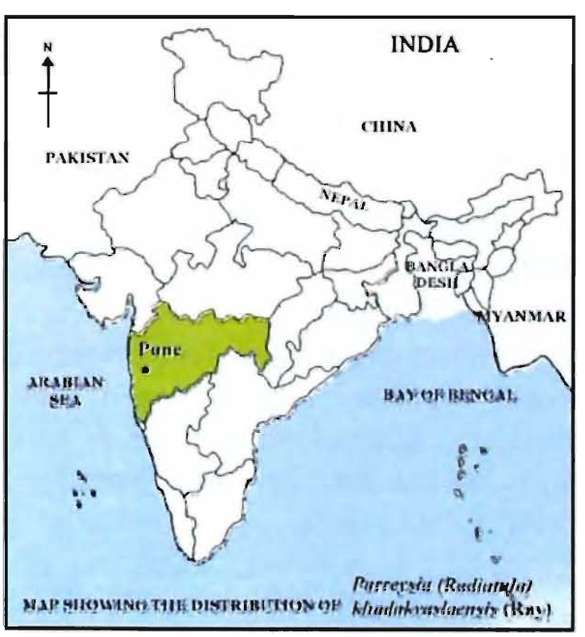
Type location : National Zoological Collection, ZSI, Regd. No. M 17531/3 (Holotype), M 17532/3 (Paratype).

Latest name and Reference : *Parreysia (Radiatula) khadakvaslaensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 190, figs. 514, 515.

Diagnosis : Shell elongated more inflated, postereior end pointed; sculpture appears to be a little more pronounced.

Distribution : India : Maharashtra: Pune.

Remarks : This species having similarity with *P. (R) pachysoma* (Benson) but it differs from it by having pointed posterior end and more pronouced sculpture.



Parreysia (Radiatula) lima (Simpson, 1900)

1900. *Nodularia (Radiatula) lima* Simpson, *Proc. U. S. natn. Mus.*, **22** : 820.

1908. *Unio siliguriensis* : Preston, *Rec. Indian Mus.*, **2** : 47, fig. 7. Type locality, Siliguri, West Bengal.

1915. *Nodularia (Radiatula) lima* : Preston, *Fauna Brit India Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 147.

1921. *Indonaia lima* Prashad, *Rec. Indian Mus.*, **22** : 604.

Fig. 242. A. Exterior view of *Parreysia (Radiatula) lima* (Simpson)

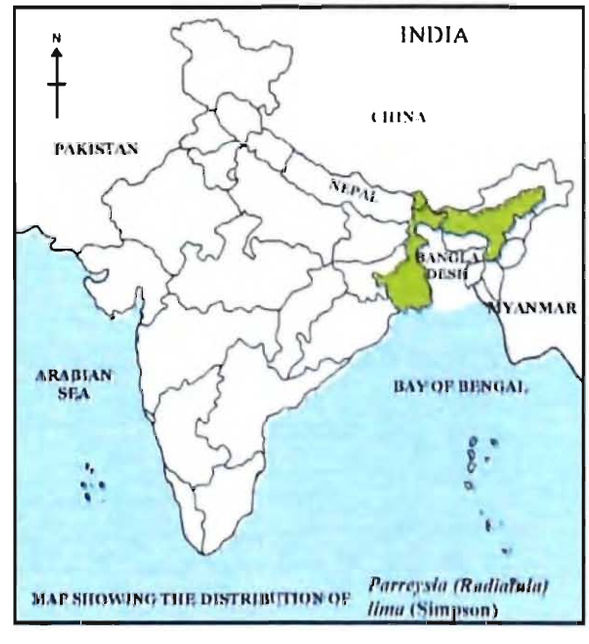
Fig. 242. B. Interior view of *Parreysia (Radiatula) lima* (Simpson)

Type location : USNM, National Zoological Collection, ZSI, Regd. No. M 6099/1 (Holotype of *U. siliguriensis* Preston.

Latest name and Reference : *Parreysia (Radiatula) lima* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 190, figs. 528-531.

Diagnosis : Shell small with broad posterior end; umbo much anterior, scarecely raised; sculpture conspicuous, more prominent on umbonal region, zig-zag and transverse ines promiment on posterior side, finer on anterior. Highly variable species, greenish in colour.

Distribution : India : Assam, Sikkim and West Bengal.



Parreysia (Radiatula) nuttalliana (Lea, 1856)

1856. *Unio nuttallianus* Lea, *Proc. Acad. nat. Sci. Philad.*, **8** : 103. Type locality : India.

1915. *Nodularia (Nodularia) nuttalliana* : Preston, *Fauna Brit India Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 145.

Fig. 243. A. Exterior view of *Parreysia (Radiatula) nuttalliana* (Lea)

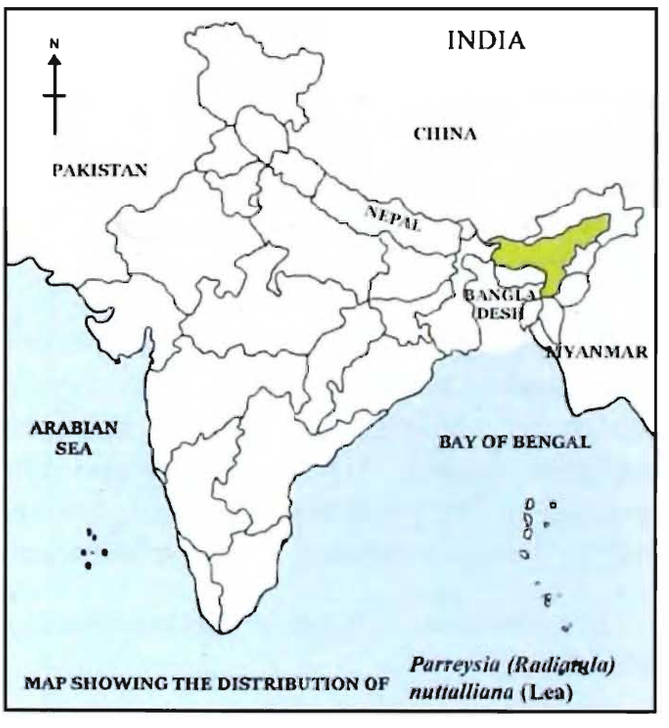
Fig. 243. B. Interior view of *Parreysia (Radiatula) nuttalliana* (Lea)

Type location : USNM.

Latest name and Reference : *Parreysia (Radiatula) nuttalliana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 190, figs. 428, 429, 532, 533.

Diagnosis : Shell small, smooth, devoid of any sculpture; umbo prominent, middle; olive green in colour.

Distribution : India : Assam : Cachar.



Parreysia (Radiatula) occata (Lea, 1860)

1860. *Unio occatus* Lea, *Proc. Acad. nat. Sci. Philad.*, **4** : 307. Type locality : Bengal.

1915. *Nodularia (Nodularia) occata* : Preston, *Fauna Brit India Mollusca* (Freshwater Gastropoda and Pelecypoda) : 138.

1921. *Indonaia occata* : Prashad, *Rec. Indian Mus.*, **22** : 603.

1989. *Parreysia (Radiatula) occata* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 191, figs. 426, 427, 526, 527.

Fig. 244. A. Exterior view of *Parreysia (Radiatula) occata* (Lea)

Fig. 244. B. Interior view of *Parreysia (Radiatula) occata* (Lea)

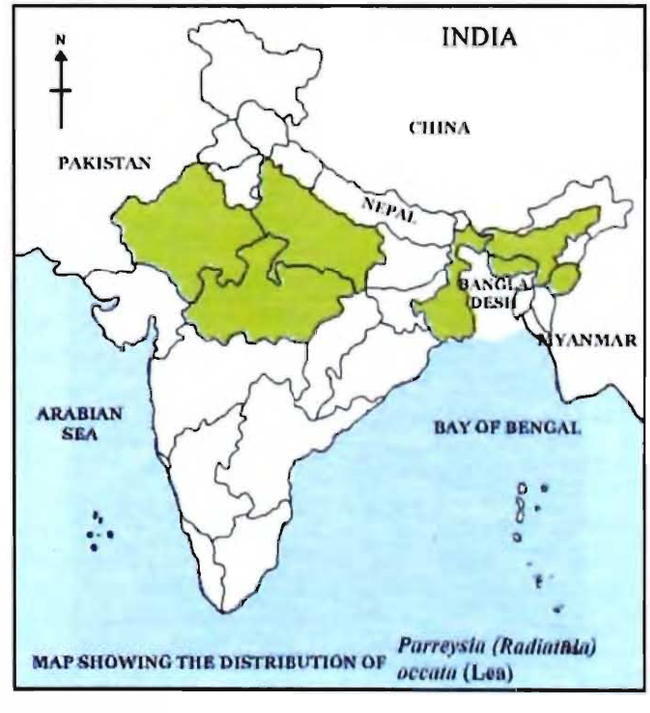
Type location : USNM.

Latest name and Reference : *Parreysia (Radiatula) occata* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 88. *Zool. Surv. India.*

Diagnosis : Shell rather rhomboidal, narrow; dorsal side less convex; umbo little more central; typically sculptured with granular ridges throughout the surface.

This species closely resembles with *Parreysia (Radiatula) lima* (Simpson).

Distribution : India : Assam, Madhya Pradesh, Manipur: Chandel; Meghalaya: Garo hills (West); Rajasthan, Uttar Pradesh, West Bengal: Kolkata.



Elsewhere : Bangladesh; Myanmar; United Kingdom.

Parreysia (Radiatula) olivaria (Lea, 1831)

1831. *Unio olivarius* Lea, *Trans. Amer. Phil. Soc.*, **4** : 108, pl. 16, fig. 38. Type locality : Burrail river, north of Cachar, Assam.

1915. *Nodularia (Nodularia) olivaria* : Preston, *Fauna Brit India Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 144.

Fig. 245. A. Exterior view of *Parreysia (Radiatula) olivaria* (Lea)

Fig. 245. B. Interior view of *Parreysia (Radiatula) olivaria* (Lea)

Fig. 246. A. Exterior view of *Parreysia (Radiatula) olivaria* (Lea) (Type)

Fig. 246. B. Interior view of *Parreysia (Radiatula) olivaria* (Lea) (Type)

Type location : ANSP (Syntypes)

Latest name and Reference : *Parreysia (Radiatula) olivaria* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 191, figs. 534, 535.

Diagnosis : Shell is comparatively small, thin, devoid of any sculpture; umbo prominent and middle; olive green colour.

Distribution : India : Assam, Meghalaya : Garo hills (West); Uttar Pradesh : Agra, Moradabad; West Bengal : Raniganj.

Parreysia (Radiatula) pachysoma (Benson, 1862)

1862. *Unio pachysoma* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 186. Type locality : "Barhampooter river, Assam."

1915. *Nodularia (Nodularia) pachysoma* : Preston, *Fauna Brit. India Mollusca*, (Freshwater Gastropoda and Pelecypoda) : 139.

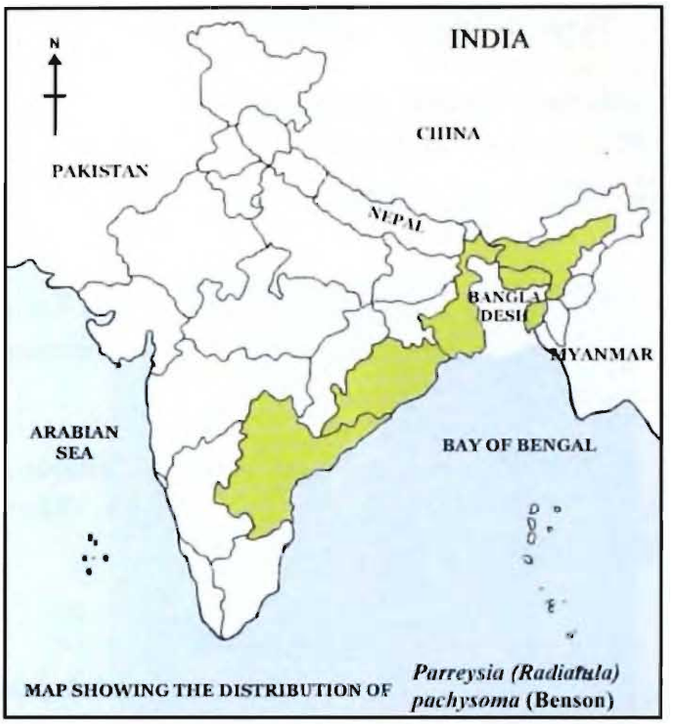
1989. *Parreysia (Radiatula) pachysoma* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 192, figs. 540, 541.

Fig. 247. A. Exterior view of *Parreysia (Radiatula) pachysoma* (Benson)

Fig. 247. B. Interior view of *Parreysia (Radiatula) pachysoma* (Benson)

Type location : Natural History Museum, London.

Latest name and Reference : *Parreysia (Radiatula) pachysoma* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 216. *Zool. Surv. India.*



Diagnosis : Shell more elongate, inflated; umbo pronounced, with much stronger hinge, radial sculpture absent.

This species resembles *Parreysia (Radiatula) bonneaudi* (Edyoux) and *Parreysia (Radiatula) caerulea* (Lea). It differs from *P. (R.) bonneaudi* by more elongate and inflated shells, pronounced umbone and much stronger hinge and from *P. (R.) caerulea* by its much brighter and more inflated shell, lacking of radial sculpture on the sides.

Distribution : India : Andhra Pradesh : Khammam, Assam, Meghalaya : Garo hills (East); Orissa, West Bengal : Kolkata; Tripura.

Elsewhere : Bangladesh; Myanmar.

Parreysia (Radiatula) shurtleffiana (Lea, 1856)

1856. *Unio shurtleffiana* Lea, *Proc. Acad. nat. Sci. Philad.*, **8** : 94.

Fig. 248. A. Exterior view of *Parreysia (Radiatula) shurtleffiana* (Lea)

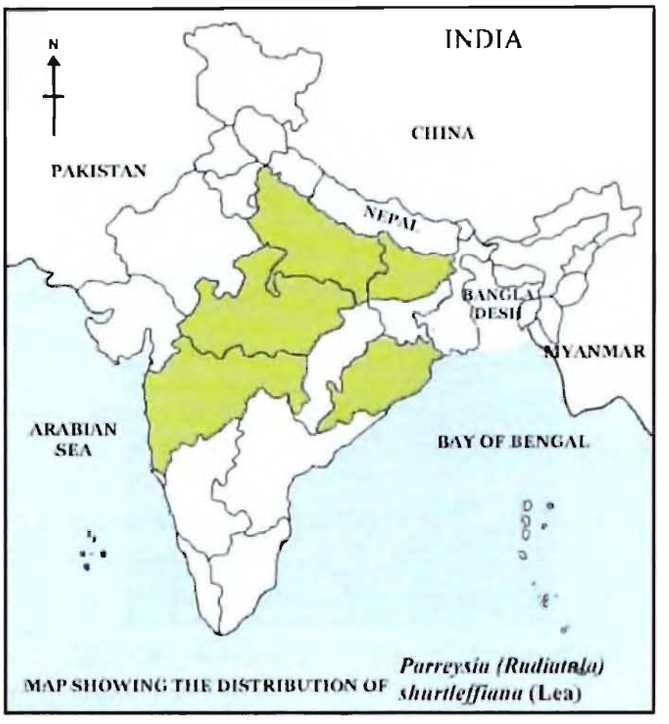
Fig. 248. B. Interior view of *Parreysia (Radiatula) shurtleffiana* (Lea)

1915. *Nodularia (Nodularia) shurtleffiana* : Preston, *Fauna Brit India Mollusca*, (Freshwater Gastropoda and Pelecypoda), p. 138.

Type location : USNM

Latest name and Reference : *Parreysia (Radiatula) shurtleffiana* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 192, figs. 512, 513.

Diagnosis : This species is very similar with *Parreysia (Radiatula) olivaria* Lea) and *Parreysia (Radiatula) nuttalliana* (Lea) but differs from them by having some typical sculpture on umbonal region and also on anterior slope.



Distribution : India : Bihar, Madhya Pradesh, Maharashtra : Ahmednagar; Orissa, Uttar Pradesh.

Parreysia (Radiatula) theobaldi (Preston, 1912)

1912. *Nodularia (Nodularia) theobaldi*, Preston, *Rec. Indian Mus.*, **7** : 292. Type locality : Manipur.

1921. *Indonaia theobaldi* : Prashad, *Rec. Indian Mus.*, **22** : 604.

1989. *Parreysia (Radiatula) theobaldi* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 192, figs., 536-539.

Fig. 249. A. Exterior view of *Parreysia (Radiatula) theobaldi* (Preston)

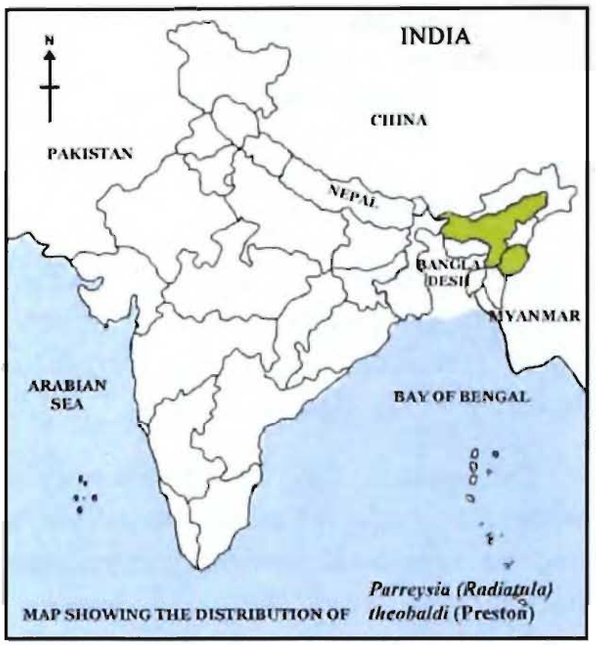
Fig. 249. B. Interior view of *Parreysia (Radiatula) theobaldi* (Preston)

Type location : National Zoological Collection, ZSI, Regd. No. M 4710 (Holotype), M 2478/1 (Cotype).

Latest name and Reference : *Parreysia (Radiatula) theobaldi* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 88. *Zool. Surv. India.*

Diagnosis : Shell broad and elongate; sculpture absent on dorsal surface.

Distribution : India : Assam, Manipur.



Genus ***Trapezoideus*** Simpson, 1900

1900. *Trapezoideus* Simpson, *Proc. U. S. natn. Mus.*, **22** : 858. Type species : *Unio foliacea* Gould, 1843; Original designation.

Shell trapezoid in shape, compressed with low posterior slope; Umbo not so prominent, ornamented with zig-zag concentrical sculpture, surface concentrically sulcate; hinge with elongated cardinal teeth.

Outer gill shorter in length than inner, but with same width at posterior margin; labial palps large; branchial aperture large with many rows of elongate papillae on the margins; margin of anal aperture with minute single row of papillae.

Geological Range : Recent

South and South-east Asia

Trapezoideus exolescens exolescens (Gould, 1843)

1843. *Unio exolesceus* Gould, *Proc. Boston Soc.nat. Hist.*, **1** : 141. Type locality : Tavoy, Myanmar.

1843. *Unio foliaceus* Gould, *Proc. Boston Soc. nat. Hist.*, **1** : 141. Type locality : Tavoy, Myanmar.

1865. *Unio misellus* Morelet, *J. Conch. Paris.*, **13** : 21. Type locality : Siam.

1866. *Unio siamensis* Lea, *Proc. Acad. nat. Sci. Philad.*, **10** : 133. Type locality : Siam.

1899. *Unio misellus* var. *subclathratus* Martens, *Arch. Naturqesch.*, **65** : 44, pl. 6, fig. 3. Type locality : Chindwin river near Kalewa, Myanmar.

1912. *Trapezoideus foliaceus* var. *zayleymanensis* Preston, *Rec. Indian Mus.*, **7** : 307. Type locality : Bhamo, Myanmar.

Fig. 250. A. Exterior view of *Trapezoideus exolescens exolescens* (Gould)

Fig. 250. B. Interior view of *Trapezoideus exolescens exolescens* (Gould)

1921. *Trapezoideus dhanushori* Prashad, *Rec. Indian Mus.*, **22** : 611, fig. 31. Type locality : Dhanushori stream, about a mile from Dimapur, Nagaland.

1974. *Trapezoideus exolesceus exolesceus* : Brandt, *Arch. Moll.*, **105** : 299, pl. 26, fig., 63.

1989. *Trapezoideus exolesceus exolesceus* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 194, figs. 432, 433, 548-557.

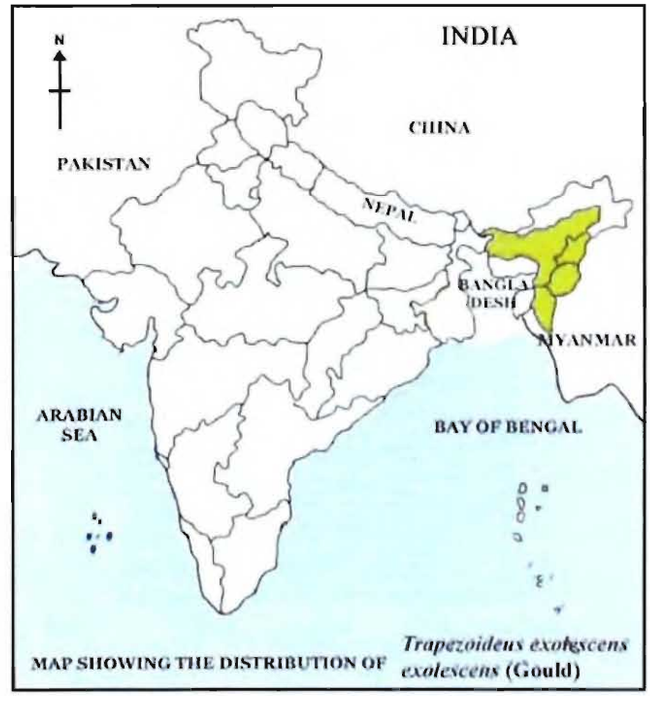
Type location : USNM; National Zoological Collection, ZSI Regd. No. M 11962/2 (Type of *T. dhanushori* Prashad)

Latest name and Reference : *Trapezoideus exolesceus exolesceus* : Surya Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 88. *Zool. Surv. India*.

Diagnosis : Shell thin, trapezoidal, brownish yellow, compressed, umbones depressed, anterior end narrow, short, posterior side dilated, posterior wing not distinct.

Distribution : India : Assam, Manipur, Mizoram, Nagaland.

Elsewhere : Myanmar : Mandalay, Bhamo, Tenasserim, Zayleymann; Siam.



Superfamily MUTELOIDEA

Family ETHERIIDAE

Shell regular and free (orthothetic) when young, nacreous, irregular, attached by surface of one valve (peurothetic) when adult. Shell substance foliaceous or lamellar; periostracum deciduous, thick and olive coloured; hinge edentulous; anterior adductor scar reduced in some forms. Foot obsolete in adult. Labial palps large.

Geological range : Pliocene to Recent.

India, Malagasy and tropical Africa, South America.

This family includes four genera but only *Pseudomulleria* is reported from India.

Genus ***Pseudomulleria*** Anthony, 1907

1907. *Pseudomulleria* Anthony, *Ann. Soc. malac. Belg.*, **4** : 407 (Type species : *Mulleria dalyi* E. A. Smith, 1898; Original designation).

Shell irregular, heavy, inequivalve, quadrate and without any anterior projection; periostracum thick; umbo very much elongate; ligament in marginal groove; anterior adductor muscle scar obsolete.

Geological range : Recent

India

Pseudomulleria dalyi E.A. Smith, 1898

1898. *Mulleria dalyi* Smith, *Proc. malac. Soc. Lond.*, **3** : 14, Text fig. Type locality : Proabaly near Mudgiri, Kadur dist., Karnataka.

Fig. 251. A. Exterior view of *Pseudomulleria dalyi* E.A. Smith

Fig. 251. B. Interior view of *Pseudomulleria dalyi* E.A. Smith

1893. *Mulleria dalyi* : Woodward, *Proc. malac. Soc.* Lond., **3** : 87, Text figs. (Anatomy).

1915. *Mulleria dalyi* : Preston, *Fauna Brit. India Mollusca* (Freshwater Gastropoda and Pelecypoda), p. 197.

Type location : Natural History Museum, London.

Latest name and Reference : *Acostaea (Pseudomulleria) dalyi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 198, figs., 438, 439.

Diagnosis : Shell irregularly quadrate, periostracum deep brown or blackish brown, nacre mixture of white, greenish, bluish, olive and pinkish, margin olive brown.

Distribution : India : Western Ghats (Karnataka and Maharashtra).

Preston (1915), probably based on the original reference, gave Kadur (Karnataka) as its locality, but the collections in ZSI are from Taloshi, Koyna valley, Satara district of Maharashtra.

Woodward (1898) gave an account of anatomy of this species.

Subclass	HETERODONTA
Order	VENEROIDA
Superfamily	SOLENOIDEA
Family	CULTELLIDAE

Valves elongate, cylindrical to flattened gaping at both the ends; umbo not terminal; hinge with one to three cardinal teeth; lateral absent or weak and laminar if present; pallial sinus short.

Geological Range : Lower Cretaceous to Recent.

Genus ***Neosolen*** Ghosh, 1920

1920. *Neosolen aquaedulcioris* Ghosh, *Rec. Indian Mus.*, **19** : 57. (Type species : *Neosolen aquaedulcioris* Ghosh; Monotypy.)

Shell thin, transparent; anterior end truncated, posterior end rounded, one small long cardinal tooth, present in the right valve, anterior adductor scar long triangular; posterior adductor scar small rounded.

Eustuarine in habit occasionally found in freshwater.

South Asia.

Neosolen aquaedulcioris Ghosh, 1920

1920. *Neosolen aquaedulcioris* Ghosh, *Rec. Indian Mus.*, **19** : 57, pl. 2, fig. 12, pl. 3, figs. 13, 14. Type locality : Off Samal Island, Chilka Lake.

Fig. 252. A. Exterior view of *Neosolen aquaedulcioris* Ghosh

Fig. 252. B. Interior view of *Neosolen aquaedulcioris* Ghosh

Type location : National Zoological Collection, ZSI, Regd. No. M 9981/2 (Syntypes).

Latest name and Reference : *Neosolen aquaedulcioris* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 221, figs., 641, 642.

Diagnosis : Body flattened laterally with a narrow ventral surface, no cruciform muscle, siphons fused, long and segmented with tentacular fringe around its aperture, gills plicate, short and deep.

Distribution : India : Orissa : Chilka Lake; West Bengal : Sundarbans.

Genus ***Tanysiphon*** Benson, 1858

1858. *Tanysiphon*, Benson, *Ann. Mag. nat. Hist.*, **(3) 1** : 407. (Type species : *Tanysiphon rivalis* Benson, Monotypy).

Shell small, thin, elongately-ovate with greenish periostracum; umbo anteior; ligament short external; hinge with three cardinal teeth in each valve, anterior two smaller and posterior one flattened; pallial sinus large, rounded.

Inhabitant of estuarine water, sometimes extended to freshwater.

Geological Range : Recent.

South Asia.

Tanysiphon rivalis Benson, 1858

1858. *Tanysiphon rivalis* Benson, *Ann. Mag. nat. Hist.*, **(3) 10** : 408, pl. 128, figs. (1-3). Type locality : Calcutta.

1876. *Tanysiphon rivalis* : Hanley and Theobald, *Conch Indica*, p. 47, pl. 116, figs. 1 & 4.

Fig. 253. A. Exterior view of *Tanysiphon rivalis* Benson

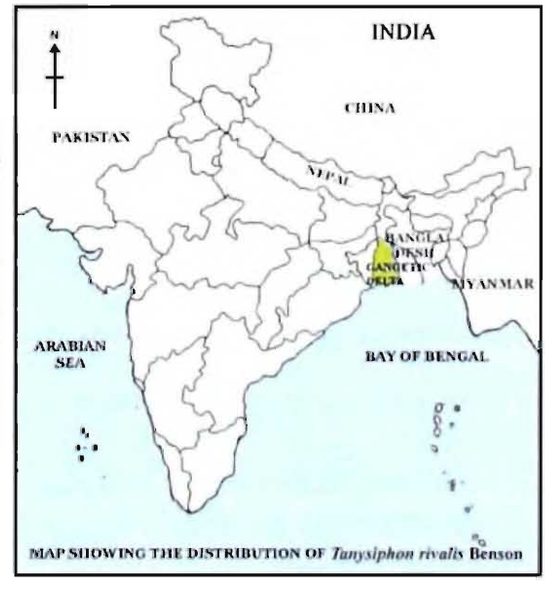
Fig. 253. B. Interior view of *Tanysiphon rivalis* Benson

Type location : Natural History Museum, London.

Latest name and Reference : *Tanysiphon rivalis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 221, figs. 639, 640.

Diagnosis : Foot hatche-shaped, thick, posterior side notched, siphons united almost equallying the length of the shell, free extremity surrounded by distantly placed, inequal tentacles, branchial siphon larger and orifice with tentacles, anal siphon smaller and orifice naked.

Distribution : India : West Bengal : Gangetic delta.



MAP SHOWING THE DISTRIBUTION OF *Tanysiphon rivalis* Benson

Superfamily TELLINOIDEA

Family PSAMMOBIIDAE

Shell inequilateral, slightly gaping in most form especially at the posterior end; ligament external or sunken in pit on hinge plate; hinge with one to three cardinal teeth; lateral teeth absent or weak; adductor muscle scars connected by pallial line with distinct sinus; Animal with two elongate separate siphons.

Marine only genus *Novaculina* extends to freshwater.

Geological Range : Upper Cretaceous to Recent.

Subfamily NOVACULININAE

Shell long, cylindrical, resembling Solenidae but soft parts resemble with Solecurtinae; umbo enterior; hinge with two to three cardinal teeth; pallial sinus small to large.

Foot short and stout with disc like, anterior end projecting forward and downward.

Geological Range : Recent

Genus ***Novaculina*** Benson, 1830

1830. *Novaculina* Benson, *Gleaning in Science,* **2** : 63, (Type species : *Novaculina gangetica* Benson, 1830; by Monotopy).

Shell subinequivalve, transversely elongated with uniform width throughout; umbo prominent, periostracum present, hinge line straight with three cardinals in left valve and two in right valve; pallial sinus of moderate depth.

Geological Range : Recent

South Asia, Freshwater.

Novaculina gangetica Benson, 1830

1830. *Novaculina gangetica* Benson, *Gleanings in Science,* Calcutta, **2** : 63.

1858. *Novaculina gangetica* Benson, *Ann. Mag. nat. Hist. Lond.,* **(3)10** : 408, pl. 12B, fig. 4.

1876. *Novaculina gangetica* : Hanley and Theobald, *Conch Indica,* p. 41, pl. 116, fig. 7.

1915. *Novaculina gangetica* : Preston, *Fauna Brit India Mollusca* (Freshwater Gastropoda & Pelecypoda), p. 229.

Fig. 254. A. Exterior view of *Novaculina gangetica* Benson

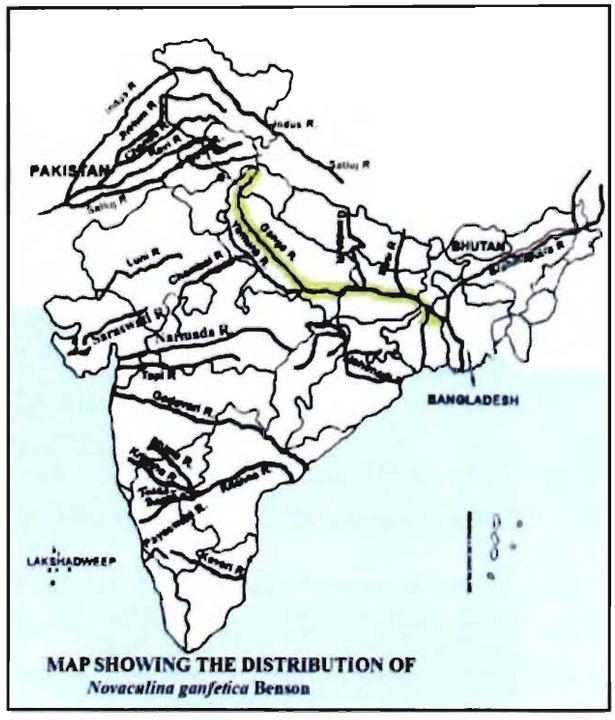
Fig. 254. B. Interior view of *Novaculina gangetica* Benson

Type location : Natural History Museum, London.

Latest name and Reference : *Novaculina gangetica* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 223, figs., 637, 638.

Diagnosis : Shell oblong with truncated extremities, periostracum olivaceous. Animal flattened in dorsoventral direction, foot stumpy with a disc like flattened surface. Branchial siphons longer and stouter than the anal, surface of siphons finely ribbed but not segmented, apertures constricted and without tentacular fringe.

Ghosh (1920) made a detail study of anatomy of this species.



Distribution : India : West Bengal : River Ganges.

Elsewhere : Bangladesh.

Superfamily CORBICULOIDEA

Family CORBICULIDAE

Shell small to moderately large, thick, rounded-triangular to oval; periostracum well developed, fibrous, yellowish, brown or green, sculpture with concentric striae or ribbed; hinge with three cardinals and one to two laterals in each valve, somewhat serrated; pallial sinus shallow or absent.

Animals with large foot ; siphonal opening prolonged into small tubes, orifies with or without papillae; gills two pairs, outer pair smaller than inner pair; the inner pair of gill serving as brood pouch.

Recent forms are found in brackishwater to freshwater; but fossil forms are also known from marine environments.

Geological Range : ? Lower Jurrassic, Middle Jurassic to Recent.

South America, Africa, Asia and Australia.

Key to tha genera

1. Shell large, more than 50 mm, ribs not even, lateral teeth not serrated .....(2)

– Shell less than 50 mm, strongly or evenly ribbed, lateral teeth serrated .... *Corbicula* Megerle von Muehlfeld

2. Lateral teeth smooth; umbonal region much inflated .....(3)

– Lateral teeth transversely grooved; umbonal region less inflated ..... *Batissa* Gray

3. Shell longer than high .....*Polymesoda* Rafinsque

– Shell higher than long ..... *Villorita* Griffith and Pidgeon

Genus ***Corbicula*** Megerle von Muehlfeld, 1811

1811. *Corbicula* Megerle von Muehlfeld, *Mag. Gesell. Naturf. Berlin,* **5** : 56. Type species : *Tellina fluminalis* Mueller, 1774; designated, ICZN, 1955.

Shell thick, rounded-trigonal; umbo prominent, central; ligament external; sculptured with strong concentric ribs; hinge with three cardinal in each valve; lateral teeth compressed, elongated, lamelliform, two on each side in right valve and one on each side on the left valve, lateral teeth mostly serrated; pallial line without sinus.

Siphon short and close, orifices without papillae; mantle margin with papillae.

Geological Range : Lower Cretaceous to Recent

Cosmopolitan.

Prashad (1928) revised the Asiatic species of *Corbicula*, including the Indian species.

Seven species are reported from Indian water.

Key to the species

1. Sculptured with very fine concentric striae and microscopic *C. bensoni* Deshayes
– Sculptured with prominent concentric striae ..... (2)
2. Periostracum shining light yellow ..... (3)
– Periostracum glossy, chocolate-brown ..... (4)
3. Shell small (<7 mm), umbo anterior, not elevated; sculptured with regular prominent, concentric striae ..... *C. krishnaea* Ray
– Shell medium (>10 mm), umbo central, elevated; sculptured not so prominent ..... *C. annandalei* Prashad
4. Umbo anterior ..... (5)
– Umbo not anterior, almost central ..... (6)
5. Shell thin, sculptured with weak concentric striae, hinge teeth weak ..... *C. assamensis* Prashad
– Shell thick, sculpture strong, hinge with prominent teeth ..... *C. striatella* Deshayes
6. Shell ovately-triangular, dorsal margin convex, posteriorly down into a regular beak like structure, pallial line wide ..... *C. peninsularis* Prashad
– Shell triangular, dorsal margin sloping, almost straight, pallial line narrow ..... *C. cashmiriensis* Deshayes

Corbicula annandalei Prashad, 1928

1928. *Corbicula annandalei* Prashad, *Mem. Indian Mus.*, **9** : 22, pl. 4, figs. 11, 12. Type locality : Varkalay, Kerala.

Fig. 255. A. Exterior view of *Corbicula annandalei* Prashad (Holotype)

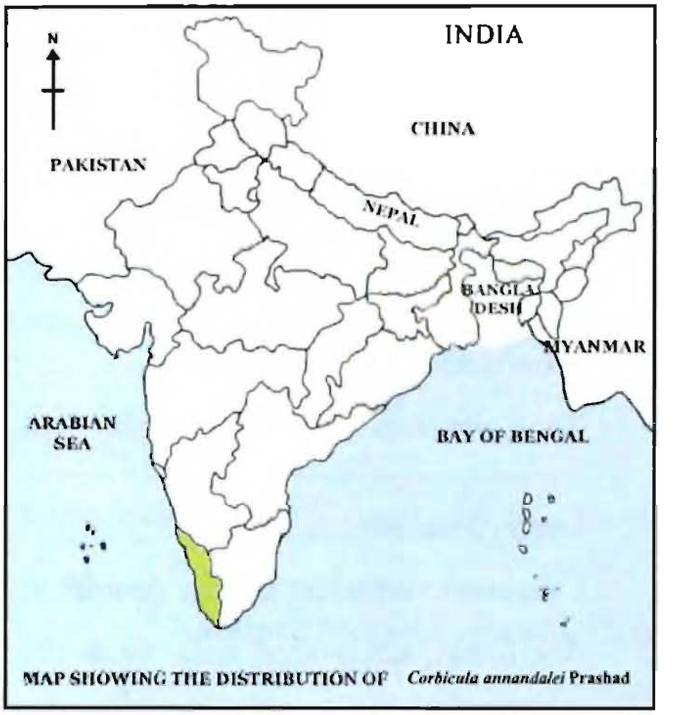
Fig. 255. B. Interior view of *Corbicula annandalei* Prashad (Holotype)

Type location : National Zoological Collection, ZSI. Regd. No. M 5253/1 (Holotype).

Latest name and Reference : *Corbicula annandalei* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 201, figs. 558 G. & H.

Diagnosis : Shell small (14 mm), thin, somewhat trigonal; umbones prominent, greatly inflated and curved forwards, dorsal margin with a steep slope on the anterior side, ventral margin slightly arched, periostracum shining light yellow, regular concentric striae, hinge very feeble.

Distribution : Known from type locality only.



MAP SHOWING THE DISTRIBUTION OF *Corbicula annandalei* Prashad

Corbicula assamensis Prashad, 1928

1928. *Corbicula assamensis* Prashad, *Mem. Indian Mus.*, **9** : 22, pl. 3, fig. 12. Type locality : Phenchooganj, Sylhet, Bangladesh

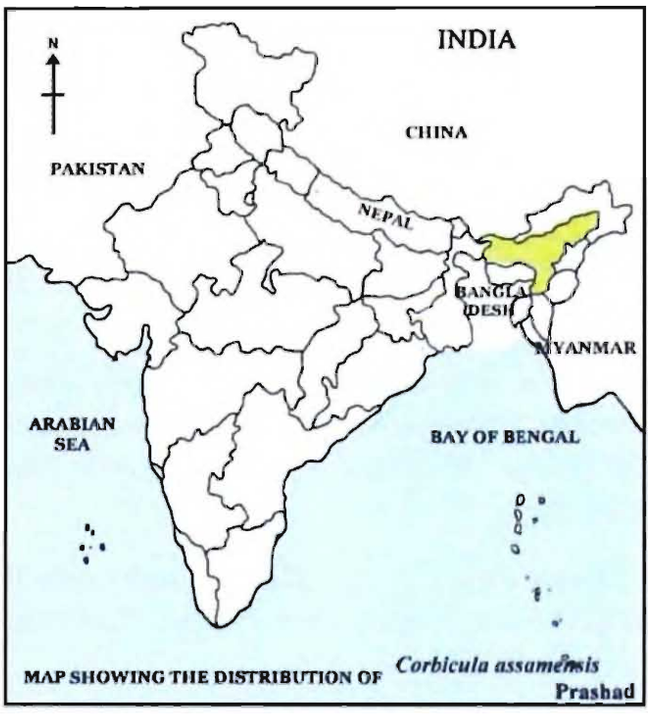
Fig. 256. A. Exterior view of *Corbicula assamensis* Prashad (Holotype)

Fig. 256. B. Interior view of *Corbicula assamensis* Prashad (Holotype)

Type location : National Zoological Collection, ZSI, Regd. No. M. 3986/1 (Holotype).

Latest name and Reference : *Corbicula assamensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 201, figs. 561, 562.

Diagnosis : Shell small (12 mm), thin, ovate or triangularly ovate, dorsal margin regularly arched, convex, anterior side short and rounded, posterior broad and truncate, ventral margin regularly arched ending in a truncated beak posteriorly, umbones slightly marked, inconspicuous, striae regular, concentric, distinct but not deep, shining light yellow colour.



Distribution : India : Assam.

Elsewhere : Bangladesh.

Corbicula bensoni Deshayes, 1854

1854. *Corbicula bensoni* Deshayes, *Proc. zool. Soc. Lond.*, : 345. Type locality : Bengal.

Fig. 257. A. Exterior view of *Corbicula bensoni* Deshayes

Fig. 257. B. Interior view of *Corbicula bensoni* Deshayes

1911. *Corbicula tribeniensis* Preston, *Rec. Indian Mus.*, **6** : 40, fig. 3. Type locality : Tribeni near Calcutta.

1928. *Corbicula bensoni* : Prashad, *Mem. Indian Mus.*, **9** : 23, pl. 4, figs. 1-4.

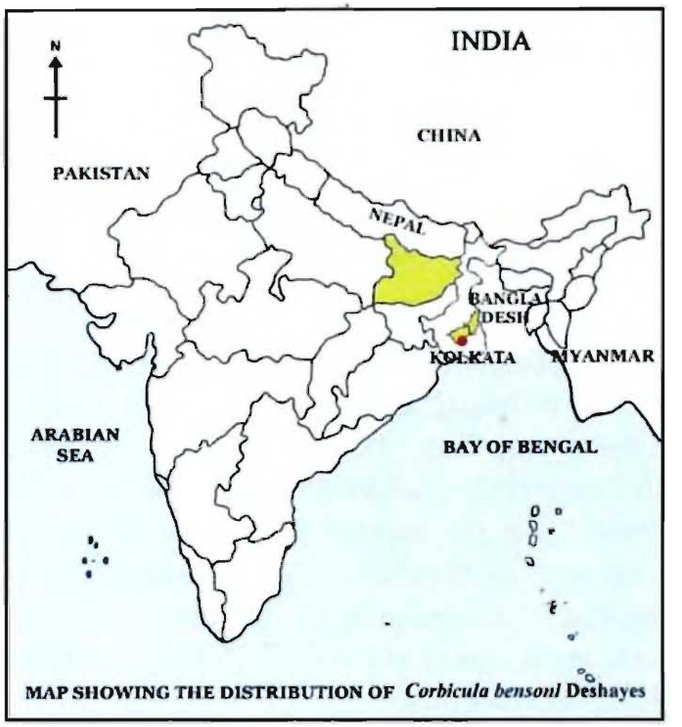
Type location : National History Museum, London.

Latest name and Reference : *Corbicula bensoni* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 202, figs. 565, 566.

Diagnosis : Shell subtrigonal, transversely ovate, thin, striae fine and microscopic.

Distribution : India : Bihar : Bhagalpur; West Bengal : Kolkata, Hugli, Nadia.

Elsewhere : Bangladesh : Chittagong.



MAP SHOWING THE DISTRIBUTION OF *Corbicula bensoni* Deshayes

Corbicula cashmiriensis Deshayes, 1854

1854. *Corbicula cashmiriensis* Deshayes, *Proc. zool. Soc. Lond.*, **1854** : 344. Type locality : Kashmir.

1928. *Corbicula cashmiriensis* : Prashad, *Mem. Indian Mus.*, **9** : 20, pl. 3, figs. 14-18.

Fig. 258. A. Exterior view of *Corbicula cashmiriensis* Deshayes

Fig. 258. B. Interior view of *Corbicula cashmiriensis* Deshayes

Type location : Natural History Museum, London.

Latest name and Reference : *Corbicula cashmiriensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India, p.* 202, figs. 567, 568.

Diagnosis : Shell trigonal, dorsal margin sloping and almost straight on either side of the umbones, ventral margin evenly arched, ending posteriorly in a distinct truncated beak in full grown specimens; sculptured with prominent raised ribs; hinge broad and strongly developed.

Distribution : India : Restricted to Kashmir.

Corbicula krishnaea Ray, 1967

1967. *Corbicula krishnaea* Ray, *Arch. Moll.*, **96** : 191, figs. 1, 2. Type locality : Krishna river, near Sangli, Pune and Maharashtra.

Fig. 259. A. Exterior view of *Corbicula krishnaea* Ray

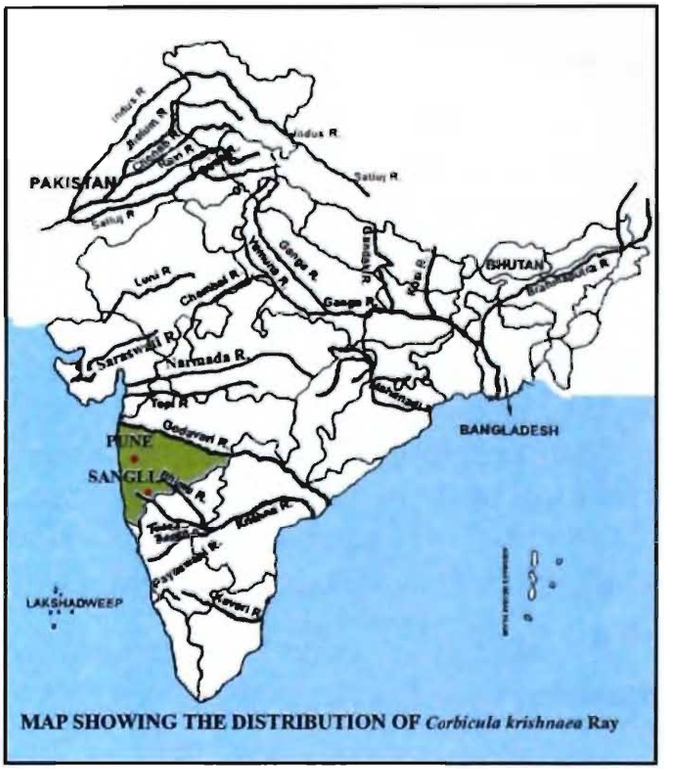
Fig. 259. B. Interior view of *Corbicula krishnaea* Ray

Type location : National Zoological Collection, ZSI Regd. No. M 17807/3 (Holotype).

Latest name and Reference : *Corbicula krishnaea* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 203, figs. 569, 570.

Diagnosis : Shell small, thin, triangularly ovate, inequilateral, anterior side narrow and more produced, posterior side broader and shorter, umbones prominent, slightly tumid, striae regular and distinct, escutcheon bearing distinct ribs, hinge plate well developed.

Distribution : Known from type locality only.



MAP SHOWING THE DISTRIBUTION OF *Corbicula krishnaea* Ray

Corbicula peninsularis Prashad, 1928

1928. *Corbicula peninsularis* Prashad, *Mem. Indian Mus.*, **9** : 21, pl. 4, figs. 13-16. Type locality : Bombay.

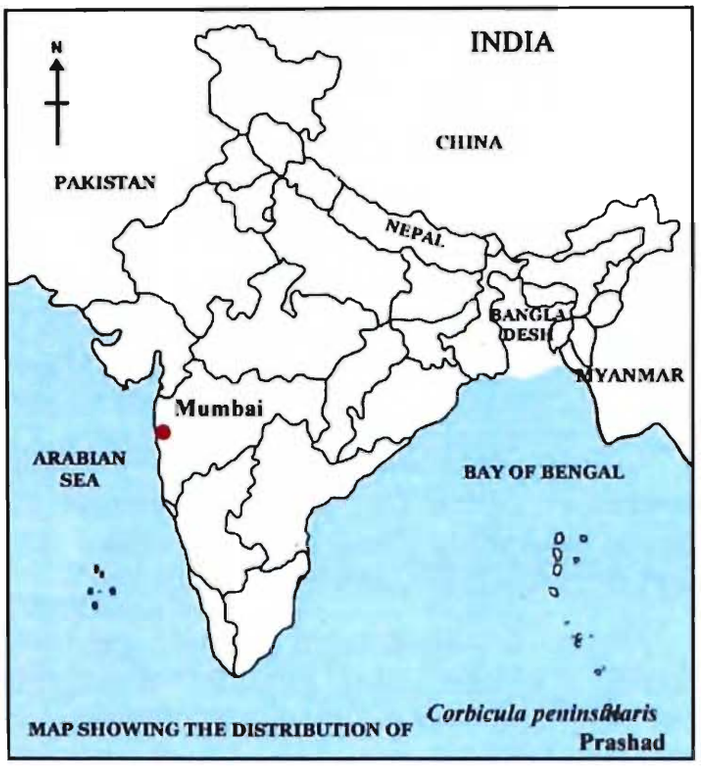
Fig. 260. A. Exterior view of *Corbicula peninsularis* Prashad

Fig. 260. B. Interior view of *Corbicula peninsularis* Prashad

Type location : National Zoological Collection, ZSI Regd. No. M 12833/2 (Holotype).

Latest name and Reference : *Corbicula peninsularis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 204, figs. 583, 584.

Diagnosis : Shell large (30 mm), thick, ovately triangular, dorsal margin very convex, posteriorly drawn out into a regular beak like structure; periostracum glossy; umbones prominent, tumid, chocolate brown colour, concentric, regular, broad and shallow ribs; hinge strongly developed, anterior laterals shorter than the posterior ones; pallial line distinctly notched.



Distribution : Known from type locality only.

Corbicula striatella Deshayes, 1854

1854. *Corbicula striatella* Deshayes, *Proc. zool. Soc. Lond.*, **22** : 344. Type locality : Pondicherry.

1928. *Corbicula striatella* : Prashad, *Mem. Indian Mus.*, **9** : 18, pl. 3, figs. 9-11.

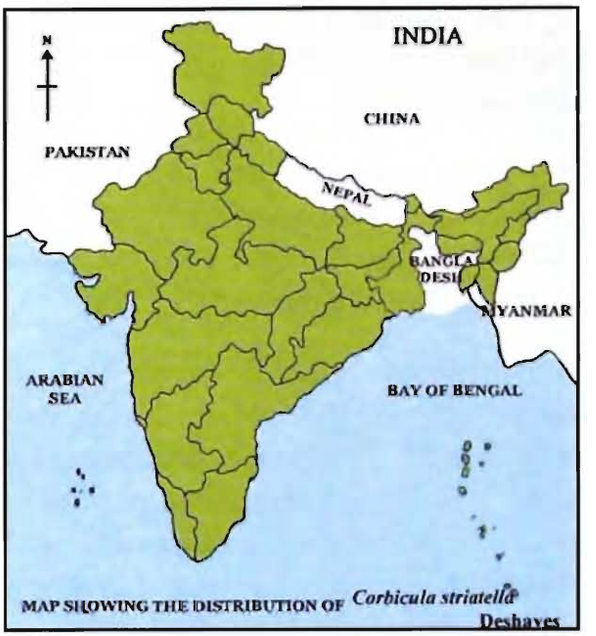
Fig. 261. A. Exterior view of *Corbicula striatella* Deshayes

Fig. 261. B. Interior view of *Corbicula striatella* Deshayes

1861. *Corbicula subradiata* : Prime, *Proc. Acad. Nat. Sci. Philad.*, : 128.

1921. *Corbicula subradiata* : Prashad, *Rec. Indian Mus.*, **22** : 613.

1989. *Corbicula striatella* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 204, figs. 575, 576.



Type location : Natural History, Museum, London.

Latest name and Reference : *Corbicula striatella* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 217. *Zool. Surv. India.*

Diagnosis : Shell large (upto 42 mm), thick, tumid, triangular ovate to ovate, dorsal margin arched, more on the anterior than posterior, umbones prominent, periostracum shining lemon yellow in young, darker and often brownish in adult, striae regular, concentric and raised into ridges, pallial line with a trace of sinus, muscle scars fairly deeply developed.

Distribution : India : Throughout. Commonest Indian species.

Elsewhere : Afganistan; Bangladesh, Myanmar; Pakistan : Peshawar, Sind; Sri Lanka.

Genus ***Batissa*** Gray, 1853

1853. *Batissa* Gray, *Ann. Mag. nat. Hist.*, **11** : 38. Type species : *Cyrena tenebrosa* Hinds, p. 1842. subsequent designation, Stoliczka, 1871.

Shell large, heavy, roundly ovate or subtrigonal, inequivalve, sculpture rough but without regular ridges; umbo dominant and anterior recurved forwards, but never touching each other; ligament strong, external; anterior region short, regularly curved; posterior region much longer; hinge with three cardinals and two laterals in each valve; cardinals divergent, laterals curved, unequal and serrated.

Mantle thicker, entire margin bears continuous row of small conical papillae on the inner surface. Pedal orifice limited anteriorly; anterior adductor muscle separated from the siphonal orifice by a long connection; adductor muscles subquadrate, posterior adductor muscle much longer than anterior; pallial muscles not distinct; siphons separate, ashy grey to violet colour; palps broad, large and leaf shaped; foot large and well developed, not very thick but with a sharp margin.

Geological Range : Middle Jurassic to Recent

Andaman and Nicobar Island and Indonesia. Common in backwaters, extended into freshwaters.

Key to the species

Shell more oblique; umbo more anteriorly placed; anterior margin short and more sloping; posterior margin curved and not biangulate ..... *B. inflata* Prime

Shell less oblique; umbo slightly anterior; anterior margin short and less sloping; posterior margin curved and biangulate ..... *B. similis* Prime

Batissa inflata Prime, 1860

1860. *Batissa inflata* Prime, *Proc. zool. Soc. Lond.*, : 320. Type locality : Nicobars.

1921. *Batissa inflata* : Prashad, *Rec. Indian Mus.*, **22** : 149, fig. 26.

Type location : Not Known.

Latest name and Reference : *Batissa inflata*, Subba Rao, 1989, *Handbook of Freshwater Molluscs of India* : 209, figs. 597, 598.

Diagnosis : Shell oblique and more inflated, umbo anterior and recurved forward, anterior margin short and more slanting, posterior margin more curved, hinge more arched but all the teeth are comparatively smaller, broader and coarser, laterals are more serrated, cardinals sharper.

Prashad (1921) studied one example from Amdaman Island which is smaller than the Prime type specimen. Subba Rao *et al.* (1980) studied one example from Andaman Island. but no specimen is available for study.

Distribution : India : Andaman and Nicobar Islands.

Batissa similis Prime, 1859

1859. *Batissa similis* Prime, *Ann. Lyceum. Nat. Hist. Soc.* New York, **7** : 112. Type locality : Nicobars.

Fig. 262. A. Exterior view of *Corbicula striatella* Deshayes

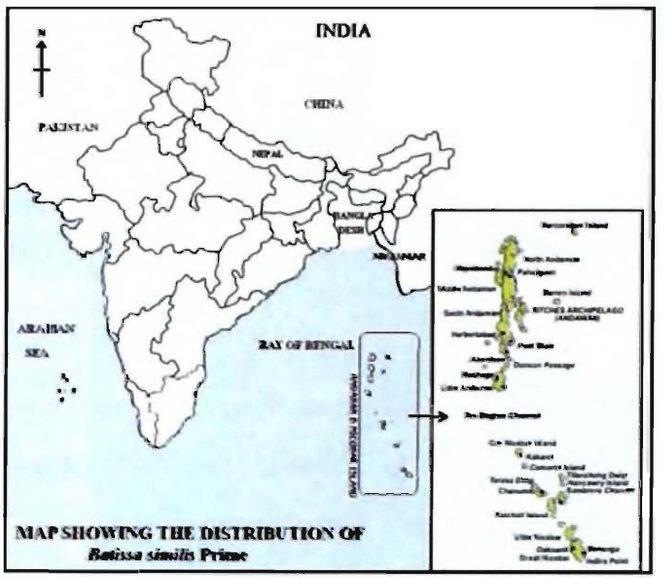
Fig. 262. B. Interior view of *Corbicula striatella* Deshayes

1908. *Batissa capillata* Preston, *Rec. Indian Mus.*, **2** : 207, pl. 16, fig. 39. Type locality : Andaman Islands.

1921. *Batissa similis* : Prashad, *Rec. Indian Mus.*, **22** : 147, fig. 2a.

Type location : National Zoological Collection, ZSI, Regd. No. M. 4054/ 1(Paratype).

Latest name and Reference : *Batissa similis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 209, figs. 597, 598.



Diagnosis : Shell subtrigonal or obovate, inequilateral; anterior side irregularly slopes down and straight or slightly concaved, posterior side much longer, biangulated distally, umbo elevated and anteriorly placed, hinge with three cardinals and two laterals in each valves, anterior lateral with a distal curved part forming a upper boundary of the impression for the anterior adductor muscle, the proximal thicker posterior lateral blade like, slightly arched and longer than anterior, both are finely serrated along the upper inner margin. Anterior cardinal small and conical in right valve, larger and knob like in left valve.

Distribution : India : Andaman and Nicobar Island.

Genus ***Polymesoda*** Rafinesque, 1820

1820. *Polymesoda* Rafinesque, *Ann. gen. Sci. Phys.* (Bruxelles), **5** : 319. Type species : *Cyclas caroliniana* Bosc, 1801; original designation.

Shell median to large, solid, thick, unequilateral; umbo prominent, incurved and almost central; hinge with three valve cardinals and two laterals in each valve, left valve with one anterior and one long posterior laterals whereas in right valve with two laterals.

Geological Range : Eocene to Recent.

Subgenus ***Geloina*** Gray, 1842

1842. *Geloina* Gray, *Synopsis Brit. Mus.*, : 75. Type species : *Cyrena zeylanica* Lamarck, 1818 = *Venus coaxans* Gmelin, 1791, subsequent designation Gray, 1847.

Shell large, solid, oval to subtrigonal, but thicker than the other two genera *Villorita* and *Batissa*; periostracum brownish green or yellowish, without conspicuous ribs; umbo, prominent, incurved and almost central; hinge with three cardinals in each valve, laterals smooth and short; pallial line entire.

Gill unequal, labial palps triangular.

Geological Range : Eocene to Recent.

India, Sri Lanka, Malaya Archipelago, Philippines and Australia. Estuarine or backwater extends sometimes in freshwater.

Prashad (1921) revised the Indian species of the genus *Cyrena (Geloina)*. The species of *Geloina* are very variable and even the specimens from the same locality.

Two species *P. (G.) erosa* (Solander) and *P. (G.) bengalensis* Lamarck are reported from India.

Polymesoda (Geloina) bengalensis (Lamarck, 1818)

1818. *Cyrena bengalensis* Lamarck, *Hist. Nat. Anim. Sans. Vert.*, **5** : 554. Type locality : "Au Bengale dans les rivieres."

1932. *Geloina bengalensis* : Prashad, *Siboga Expedition, Pelecypoda*, **53C** : 175.

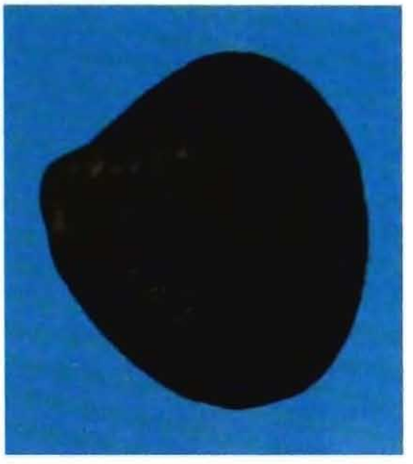


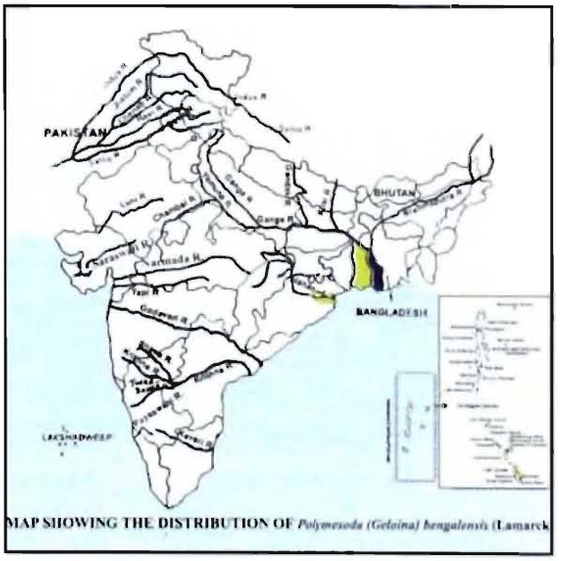
Fig. 263. A. Exterior view of *Polymesoda (Geloina) bengalensis* (Lamarck)

Fig. 263. B. Interior view of *Polymesoda (Geloina) bengalensis* (Lamarck)

Type location : MNNH

Latest name and Reference : *Geloina bengalensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 210, figs. 593, 594.

Diagnosis : Shell subtrigonal, tumid, solid, thick, inequilateral; periostracum blackish brown, coarsely striated; umbones anterior; posterior side produced, dorsal margin small with long slope, truncated at the end, anterior margin short, posterior margin long, high, markedly convex.



MAP SHOWING THE DISTRIBUTION OF *Polymesoda (Geloina) bengalensis* (Lamarck

Distribution : India : Orissa : Mahanadi estuary; West Bengal : Gangetic delta; Nicobar Island.

Elsewhere : Wide range in the Indo-Pacific region.

Polymasoda (Geloina) erosa (Solander, 1786)

1786. *Venus erosa* Solander, *Portland Catalogue*, p. 71, 186.

1932. *Geloina erosa* : Prashad, *Siboga Expedition, Pelecypoda*, **53C** : 174.

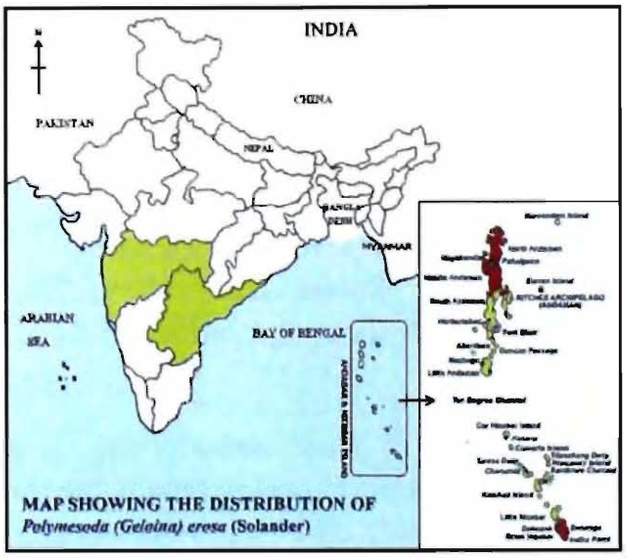
1989. *Geloina erosa* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 210, figs. 595, 596, 599, 600.

Fig. 264. A. Exterior view of *Polymasoda (Geloina) erosa* (Solander)

Fig. 264. B. Interior view of *Polymasoda (Geloina) erosa* (Solander)

Type location : Not known.

Latest name and Reference : *Polymesoda (Geloina) erosa* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, **5**(Part-5), p. 218. *Zool. Surv. India.*



Diagnosis : Shell large, subtrigonal, inequilateral, solid, periostracum thin yellowish or thick and brownish, striae indistinct and in smaller specimens fringed, posterior side obtusely two angled, flattened, anterior side rather short.

Distribution : India : Andhra Pradesh : Krishna; Andamans and Nicobar Island : Lawrence and Havelock Islands, Car Nicobar, Kondul, Trinket Island; Goa, Maharashtra.

Elsewhere : Indo-Pacific. Backwaters and estuaries.

Genus ***Villorita*** Griffith and Pidgeon, 1934

1934. *Villorita* Griffith and Pidgeon, *Animal Kingdom*, **12** : pl. 31, fig. 5. (Type species : *Cyrena cyprinoides* Gray, 1825; Original designation.)

Shell thick, solid, triangular with thick dorsal margin; umbo prominent; lunule distinct; hinge with three cardinals and two laterals in each valve, cardinals oblique, middle one well developed, posterior cardinal in left valve and anterior cardinal in right valve obsolete; laterals finely serrated, anterior lateral short, thick with a groove, posterior lateral compressed, elongated and diverging; pallial line distinct but pallial sinus poorly developed.

Foot triangular. Margin with finger shaped papillae; inner pair of gill rather large, broader; anal siphon very much short, siphonal orifices papillose.

Geological Range : Recent

Orientalis. In India found in backwater of South India, occasionally in freshwater.

Prashad (1921) recognised three distinct species from the backwater of India but only *Villorita cornucopia* Prashad found in freshwater. He also described the detail soft part of *V. cyprinoides* (Gray) in details.

Villorita cornucopia Prashad, 1921

1921. *Villorita cornucopia* Prashad, *Rec. Indian Mus.*, **22** : 118, pl. 15, figs. 11-14. Type locality : Komarakan, Vembanad Backwaters, and Kerala.

Fig. 265. A. Exterior view of *Villorita cornucopia* Prashad

Fig. 265. B. Interior view of *Villorita cornucopia* Prashad

Type location : National Zoological Collection, ZSI, Regd. No. M 11896/2.

Latest name and Reference : *Villorita cornucopia* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 207, figs. 589, 590.

Diagnosis : Shell high and narrow, anterior margin long and regularly curved, posterior margin much longer than the anterior, dorsal margin broadly arched, ventral margin almost straight, umbones comparatively broad, high and recurved umbonal region with coarse concentric ridges, ligament very long and thick.

Distribution : India : Kerala Backwaters, occassionally found in freshwaters.

MAP SHOWING THE DISTRIBUTION OF *Villorita cornucopia* Prashad

Family PISIDIIDAE

Shell small to minute, oval or subtriangular to quadrate; ligament partially or completely internal; sculpture with concentric striae or ribbed, hinge narrow curved, cardinal teeth small, not more than two in each valve; in left valve teeth are wholly separate; in right valve teeth are straight or united forming inverted V; lateral teeth two in each valve, one anterior and one posterior.

Mantle flaps separate; siphon one or two; gills two pairs situated on either side, the inner pair of gill serve as marsupium. Hermaphrodites.

Geological Range : Cretaceous to Recent.

This family includes five genera, but only two genera *Sphaerium* and *Pisidium* recorded from India.

Key to the genera

- Anterior end of shell larger than posterior end; beaks posterior or subcentral on posterior side ..... *Pisidium* Pfeiffer

- Anterior end shorter than posterior end; beaks anterior or subcentral on anterior side ..... *Sphaerium* Scopoli.

Genus ***Pisidium*** Pfeiffer, 1821

1821. *Pisidium*, Pfeiffer, *Natur. Deut. Land. und Wasser-Schnecken*, Molluke, **I** : 17, 123, pl. 1,fig. 19. Type species: *Tellina amnica* Mueller, 1774; subsequent designation, Gray, 1847.

Shell small, globose or subtriangular, thin inequilateral, posterior side broader and shorter than anterior; beaks posterior; sculpture with fine concentric striae; ligament subexternal; hinge with cardinal and lateral teeth; cardinal two in left valve and one in right valve, laterals two in right valve and one in left valve; periostracum olive horny.

Animal with one siphon, the branchial siphon absent; embryos developed in anterior gill with thick walled sacs; byssal gland absent.

Geological Range : Upper Cretaceous to Recent.

Mud dwellers, cosmopolitan.

Prashad (1925, 1933) dealt in details the species of *Pisidium* found in India, Tibet, Yarkand, Persia and Syria.

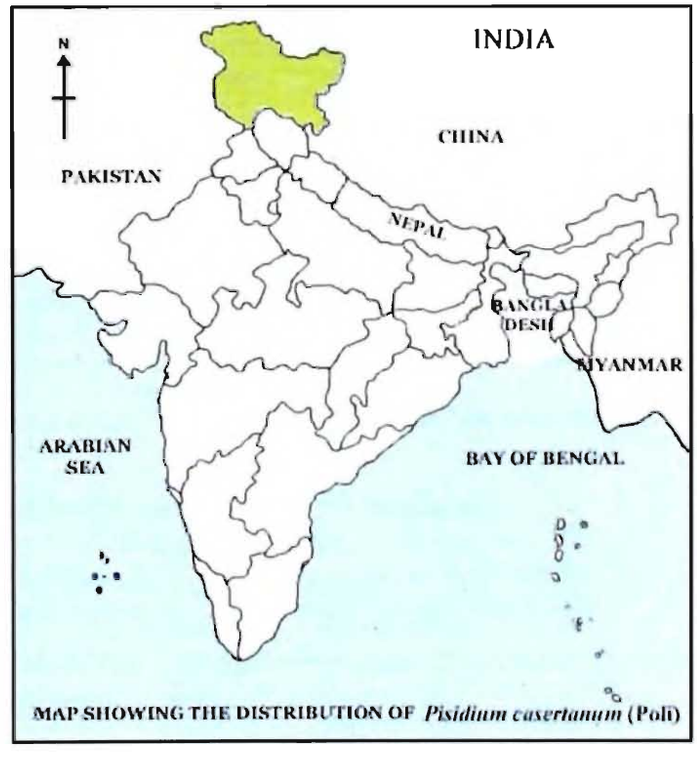
Subgenus ***Pisidium*** s.st.

Pisidium (Pisidium) casertanum (Poli, 1791)

1791. *Cardium casertanum* Poli, *Test. Utr. Sicil.*, **1** : 65, pl. 16, fig. 1. Type locality : Sicily.

1878. *Pisidium hydaspicola* Theobald, *J. Asiat. Soc. Beng.*, **47** : 147. Type locality : Stream near Shupion, Kashmir.

Fig. 266. A. Exterior view of *Pisidium (Pisidium) casertanum* (Poli)



MAP SHOWING THE DISTRIBUTION OF *Pisidium casertanum* (Poli)

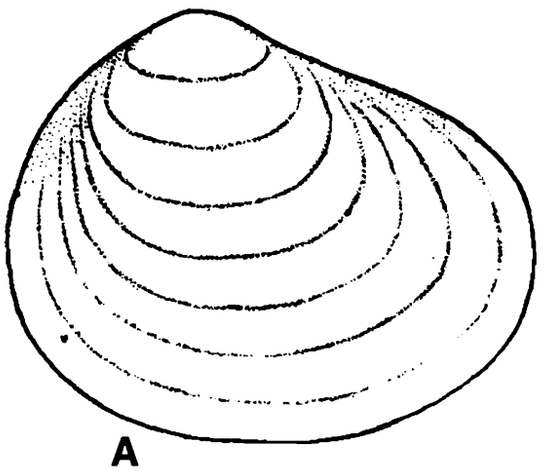


Fig. 267. A. Exterior view of ***Pisidium (P.) casertanum*** (Poli)

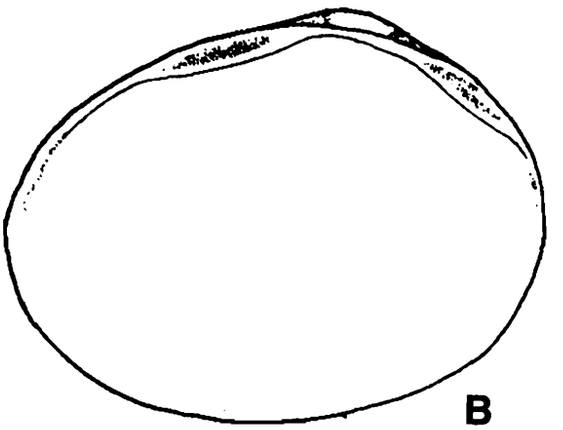


Fig. 267. B. Ventral view of ***Pisidium (P.) casertanum*** (Poli)

1925. *Pisidium hydaspicola* : Prashad, *Rec. Indian Mus.*, **27** : 414, pl. 7 & 8.

1974. *Pisidium (Pisidium) casertanum* : Brandt, *Arch. Moll.*, **105** : 329, pl. 30, fig. 4.

Type location : Not known.

Latest name and Reference : *Pisidium (Pisidium) casertanum* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 215, figs. 617, 618.

Diagnosis : shell ovate, subcordate, strong, somewhat tumid, feeble but distinct concentric striae, more distinct in the young shells than in the old, dorsal margin sloping regularly, more along the anterior than on the posterior side, ventral margin nearly straight; ligament pit long and deep extending to about the middle of the hinge plate; juveniles yellowish, full grown shells deep yellow with darker olive bands.

Distribution : India : Kashmir (Cosmopolitan)

Subgenus *Afropisidium* Kuiper, 1962

1962. *Afropisidium* Kuiper, *Jour. Conchyl.*, **102** : 55. Type species: *Pisidium lepus* Kuiper, 1957; original designation.

One pair of gill, ligament external, its fossette turn outward.

Geological Range : Recent.

Africa, Asia, Newzealand.

Pisidium (Afropisidium) clarkeanum G. & H. Nevill, 1871

1871. *Pisidium clarkeanum* G. & H. Nevill, *J. Asiat. Soc. Beng.*, **40** : 9, pl.1, figs. 4, 4a-d. Type locality : Moisrakha, on the banks of the Damodar River in Bengal.

1925. *Pisidium clarkeanum* : Prashad, *Rec. Indian Mus.*, **27** : 408, pl. 7, figs. 1, 2., pl. 8, figs. 1-3.

1989. *Pisidium (Afropisidium) clarkeanum* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 218, figs. 615, 616.

Fig. 268. A. Exterior view of *Pisidium (Afropisidium) clarkeanum* G. & H. Nevill

Fig. 268. B. Interior view of *Pisidium (Afropisidium) clarkeanum* G. & H. Nevill

Type location : National Zoological Collection, ZSI Regd. No. M 12531/2.

Latest name and Reference : *Pisidium (Afropisidium) clarkeanum* : Subba Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 90. *Zool. Surv. India.*

Diagnosis : Shell inflated, moderately thick, with distinct dorsal anterior slope, somewhat curved, ventral margin slightly curved, umbo projecting greatly over the hinge, surface pale yellow with close-set striae, much closer on the body than on the umbonal region, ligament prominent, thick, of a brownish colour, ligament pit narrow, about $^{1}/_{3}^{rd}$ of the width of the hinge plate.

Distribution : India : Andhra Pradesh : Cuddapah; Bihar : Harrapur, Bhagalpur; Jharkhand, Maharashtra : Mumbai; Manipur : Chandel; Tamil Nadu : Nilgiris (alt 7400ft); Uttar Pradesh : Roorke; West Bengal : Kolkata, 24 Paraganas (South).

Elsewhere : Myanmar; Bangladesh; Thailand; Laos.

Pisidium (Afropisidium) ellisi Dance, 1967

1967. *Pisidium (Afropisidium) ellisi* Dance, *J. Conch. Lond.*, **26**(3) : 178, figs. 6-10. Type locality : Yatung, Himalaya Mountains, Sikkim, 3000 m.

Type location : Natural History Museum, London.

Latest name and Reference : *Pisidium (Afropisidium) ellisi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 219.

Diagnosis : Shell semitransparent, thin, dorsal margin sloping steeply on the posterior side, ventral margin gently curved, periostracum yellowish brown, striae fine and irregularly concentric, ligament pit long, about $^{1}/_{3}^{rd}$ length of shell.

Distribution : India : Sikkim

Pisidium (Afropisidium) nevillianum Theobald, 1876

1876. *Pisidium nevillianum* Theobald, *J. Asiat. Soc. Beng.*, **45** : 288. Type locality : Rurki (Roorke), Uttar Pradesh.

1925. *Pisidium nevillianum* : Prashad, *Rec. Indian Mus.*, **27** : 412, pls. 7 & 8.

Type location : National Zoological Collection, ZSI Regd. No. M 12532/2.

Fig. 269. A. Exterior view of *Pisidium (Afropisidium) nevillianum* Theobald

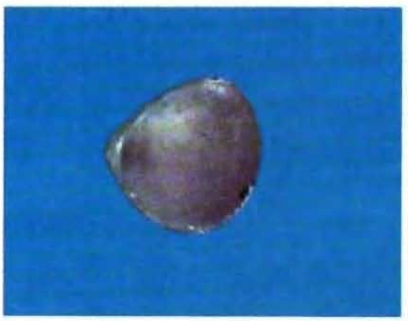


Fig. 269. B. Interior view of *Pisidium (Afropisidium) nevillianum* Theobald

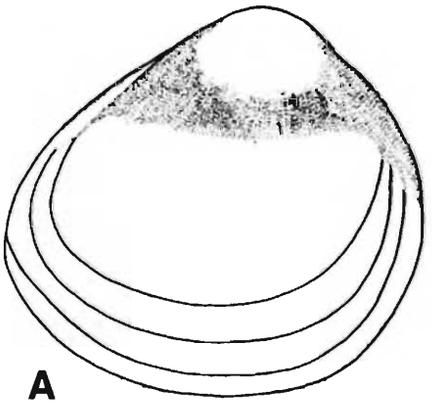


Fig. 270. A. Exterior view of ***Pisidium (A.) nevilliamum*** Theobald (Type)

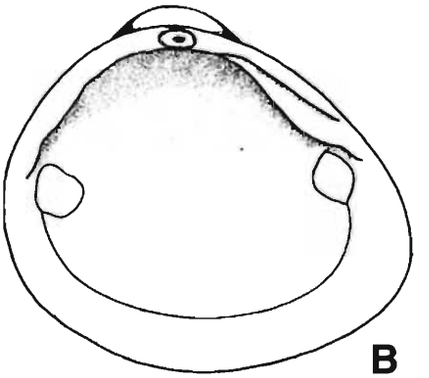


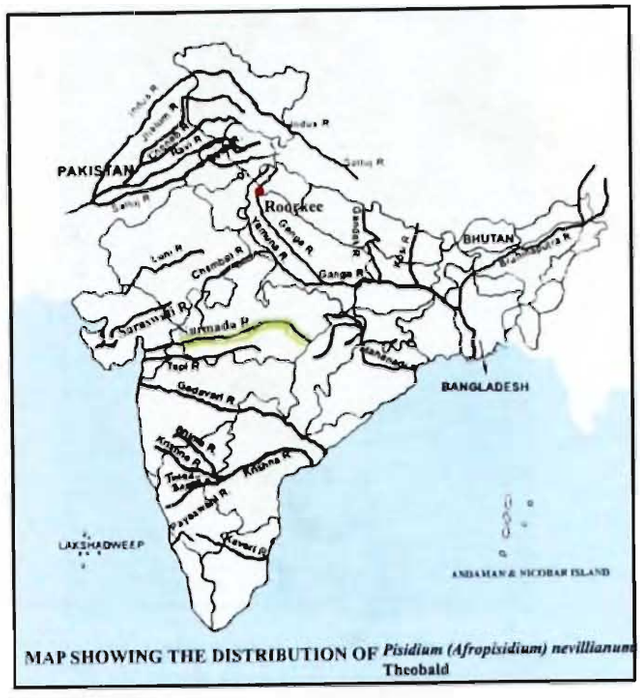
Fig. 270. B. Interior view of ***Pisidium (A.) nevilliamum*** Theobald (Type)

Latest name and Reference : *Pisidium (Afropisidium) nevillianum* Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 219, figs. 623, 624.

Diagnosis : Shell thin, large, trigonal and porcellaneous, striae all over, very distinctly marked, very regular, umbonal region with much stronger and closely placed striae, umbones prominent, round, without appendiculae, dorsal margin sloping regularly and equally on both sides of the umbo, ligament pit comparatively long and deep, nearly straight below, about half the width of the hinge-plate in the middle, narrowing gradually on either ends.

Distribution : India : Madhya Pradesh : Narmada River; Uttar Pradesh : Roorkee.

Elsewhere : Bangladesh : Bolaganj.



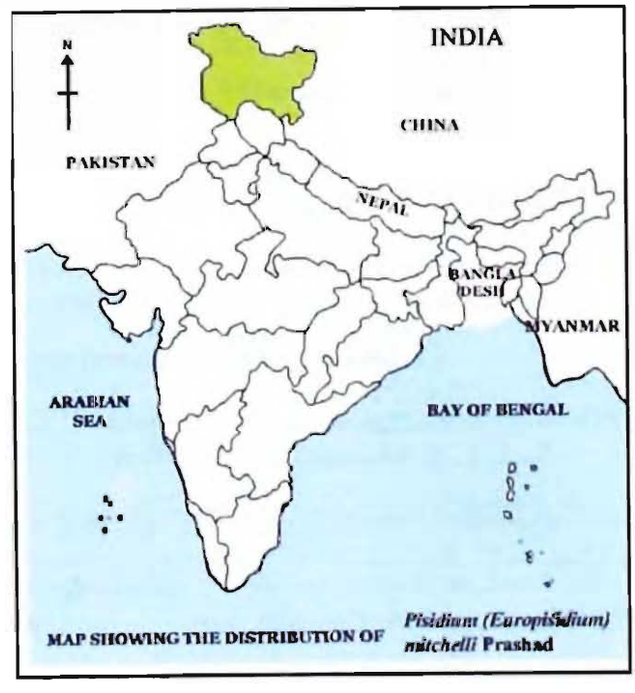
MAP SHOWING THE DISTRIBUTION OF *Pisidium (Afropisidium) nevillianum* Theobald

Subgenus ***Europisidium*** Stadnichenko, 1984

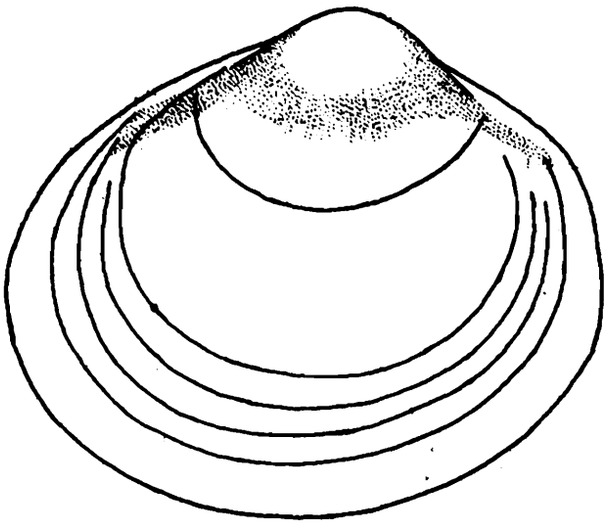
Pisidium (Europisidium) mitchelli Prashad, 1925

1925. *Pisidium mitchelli* Prashad, *Rec. Indian Mus.*, **27** : 419, pls. 7 & 8. Type locality : Srinagar, Kashmir (out of the stomach of a trout caught in the Mansabal lake at an altitude of 1500 m)

Fig. 271. Interior view of *Pisidium (Europisidium) mitchelli* Prashad

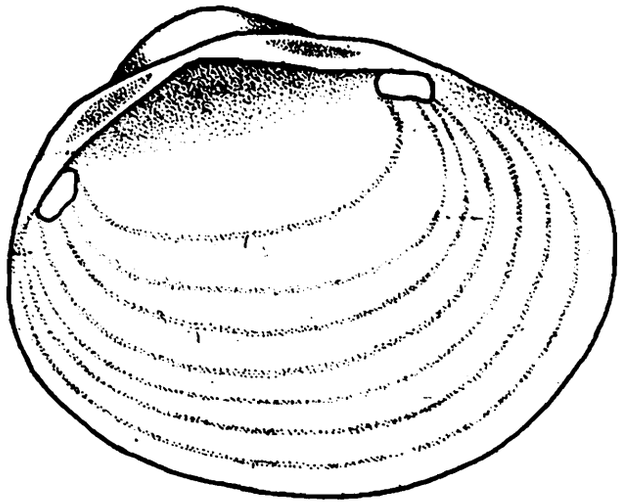


MAP SHOWING THE DISTRIBUTION OF *Pisidium (Europisidium) mitchelli* Prashad



A

Fig. 272. A. Exterior view of ***Pisidium (Europisidium) mitchelli*** Prashad



B

Fig. 272. B. Interior view of ***Pisidium (Europisidium) mitchelli*** Prashad

Type location : National Zoological Collection, ZSI Regd. No. M 12533/2.

Latest name and Reference : *Pisidium (Eupisidium) mitchelli* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 220, figs. 627, 628.

Diagnosis : Shell subtrigonal, large very tumid, thin and fragile, distinct close-set striae all over, deep horn colour, shining.

Distribution : India : Kashmir.

Subgenus ***Odhneripisidium*** Kuiper, 1962

1962. *Odhneripisidium* Kuiper, *J. Conchyl.*, **102** : 55. (Type species : *P. stewarti* Preston, 1909, original designation).

Geological Range : Recent.

Asia and Western Europe.

Pisidium (Odhneripisidium) atkinsonianum Theobald, 1876

1876. *Pisidium atkinsonianum* Theobald, *J. Asiat. Soc. Beng.*, **45(2)** : 189. Type locality : Jongla, Sikkim, at an altitude of 10,000 ft.

1925. *Pisidium atkinsonianum* : Prashad, *Rec. Indian Mus.*, **27** : 417, pls. 7 & 8.

1989. *Pisidium (Odhneripisidium) atkinsonianum* : Subba Rao, *Handbook of Freshwater Molluscs of India*, p. 216, figs. 625, 626.

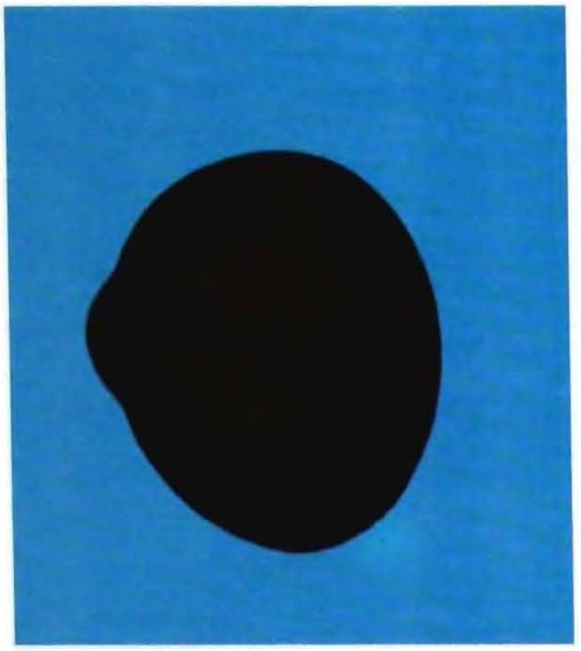
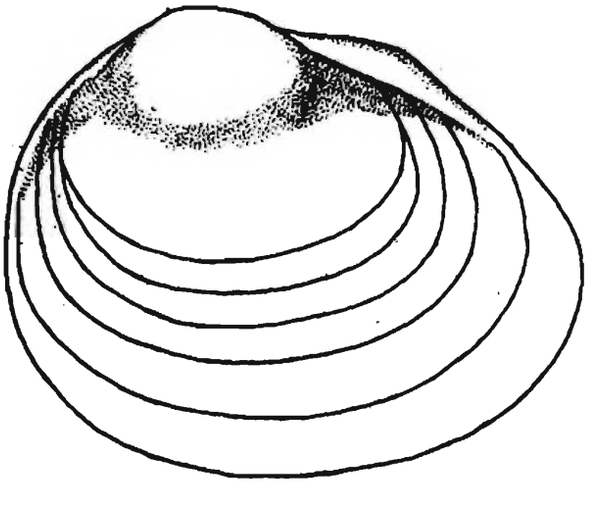


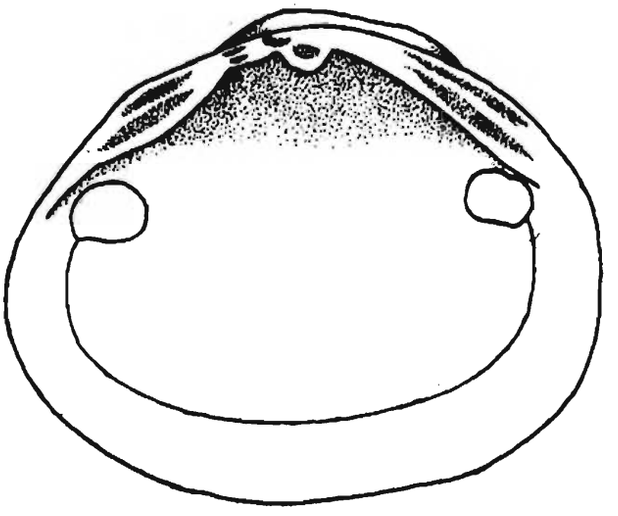
Fig. 273. A. Exterior view of *Pisidium (Odhneripisidium) atkinsonianum* Theobald

Fig. 273. B. Interior view of *Pisidium (Odhneripisidium) atkinsonianum* Theobald



A

Fig. 274. A. Exterior view of ***Pisidium (O.) atkinsonianum*** Theobald



B

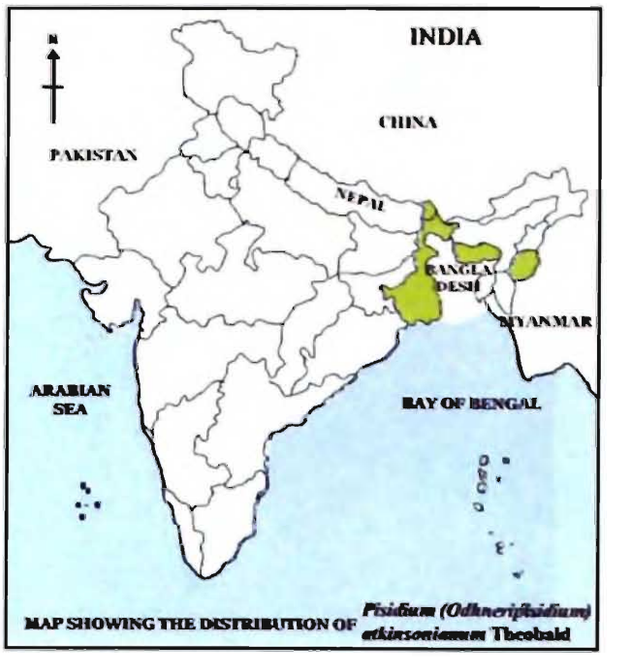
Fig. 274. B. Interior view of ***Pisidium (O.) atkinsonianum*** Theobald

Type location : Not known.

Latest name and Reference : *Pisidium (Odhneripisidium) atkinsonianum* : Subba Rao, Mookherjee, Mitra, Manna and Barua, 2004, *Fauna of Manipur, State Fauna Series*, **10**, p. 89. *Zool. Surv. India.*

Diagnosis : Shell medium, orbiculately ovate, not much swollen; umbo slightly tumid, not prominent; dorsal margin slightly sloping with well marked shoulder on the posterior slope; anterior margin subtruncate, broadly arched; posterior margin short, rounded; sculpture feebly striate in young, more distinct, irregular in adults; ligament pit about 2/3 the length of the umbo, deep, nearly reaching below the middle of the hinge plate; juveniles yellowish, adults dirty olive.

Distribution : India : Manipur : Senapati; Meghalaya : Khasi hills (East), Jantia hills; Sikkim, West Bengal : Darjeeling.



Pisidium (Odhneripisidium) kuiperi Dance, 1967

1967. *Pisidium (Odhneripisidium) kuiperi* Dance, *J. Conch. Lond.*, **26(3)** : 176, figs. 1-5. Type locality : Yatung, Himalaya Mountains, Sikkim, 3000 m.

Type location : Natural History Museum, London.

Latest name and Reference : *Pisidium (Odhneripisidium) kuiperi* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 217.

Diagnosis : Shell thin, semitransparent; umbones broad, central, not prominent; dorsal margin with a steeper slope posteriorly; ventral margin almost straight; sculpture with fine striae, irregularly spaced and concentric; periostracum pale yellowish brown; hinge plate not conspicuous, narrowed beneath the umbones; ligament pit long, about $^{1}/_{5}^{th}$ of the shell.

Distribution : India : Sikkim

Genus *Sphaerium* Scopoli, 1777

1777. *Sphaerium*, Scopoli, *Introd. Hist. Natur.*, p. 397. (Type species : *Tellina cornea* Linnaeus (ICZN Opinion 94).

Shell moderately solid, oval, quadrate in some cases bluntly triangular; beaks median without projecting caps; sculpture with concentric striae.

Animal with two siphons, the branchial and anal siphons, short and fused at their bases; byssal gland absent; embryos developed inside anterior gill with several thin walled longitudinal sacs.

Distributed in Europe, North America, Africa.

Geological Range : Cretaceous to Recent.

Key to the species

1. Umbo prominent, capped with embryonic shell, cardinal teeth weak .....(2)

– Umbo not prominent, nor capped with embryonic shell, hinge stronger..... ..... *S. indicum* Deshayes.

2. Shell subquardate, rather thick, lumbone more prominent ..... *S. austeni* Prashad

– Shell elongate ovate, rather thin, lumbone less prominent . *S. kashmirensis* Prashad

Sphaerium austeni Prashad, 1921

1921. *Sphaerium austeni* Prashad, *Rec. Indian Mus.*, **22** : 617, fig.35. Type locality : Naga Hills.

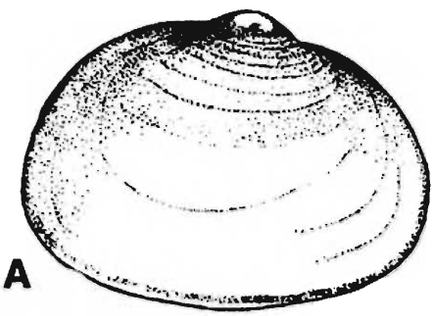


Fig. 275. A. Exterior view of ***Sphaerium austeni*** Prashad

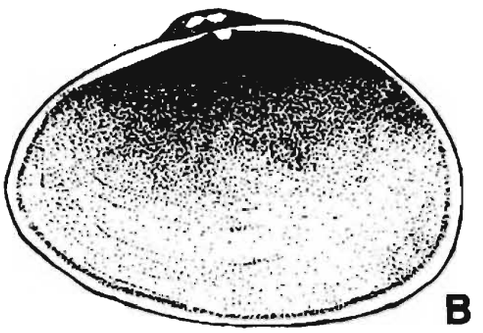


Fig. 275. B. Interior view of ***Sphaerium austeni*** Prashad

Type location : National Zoological Collection, ZSI Regd. No. M 7141-7148/1 (Syntypes).

Latest name and Reference : *Sphaerium (Sphaerium) austeni* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 212, figs. 602-605.

Diagnosis : Shell thick, elongately ovate, sub-equilateral, opaque, swollen; umbones prominent, much elevated, incurved nearly middle; anterior margin small and broadly rounded; posterior margin almost straight and truncated; ventral margin convex; sculpture smooth in young ones, with closely concentric striae in adult; epidermis dark horny to yellowish brown; hinge with one lateral and two cardinals, anterior pad like and posterior small, thin and lamellar in left valve; two laterals, lamellar, and two cardinals, anterior large and triangular, posterior small and rounded in right valve.

Distribution : India : Manipur, Nagaland.

Sphaerium indicum Deshayes, 1854

1854. *Sphaerium indicum* Deshayes, *Proc. zool. Soc. Lond.*, **22** : 342. Type locality : Rivers of India.

1921, *Sphaerium indicum* : Prashad, *Rec. Indian Mus.*, **22** : 615, fig. 34.

1989. *Sphaerium (Sphaerium) indicum* : Subba Rao, *Handbook of Freshwater Molluscs of India* : 213, figs. 600, 601, 611, 612.

Fig. 276. A. Exterior view of *Sphaerium indicum* Deshayes

Fig. 276. B. Interior view of *Sphaerium indicum* Deshayes

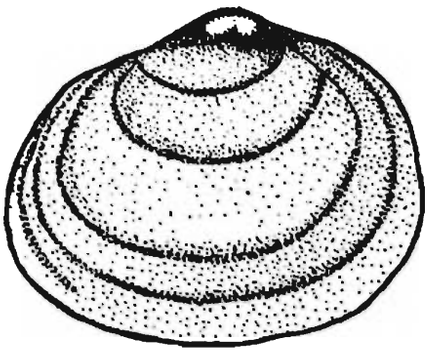


Fig. 277. A. Exterior view of ***Sphaerium indicum*** Deshayes

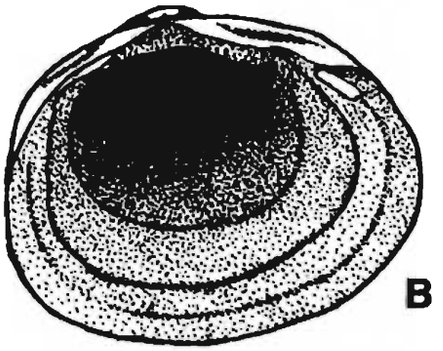


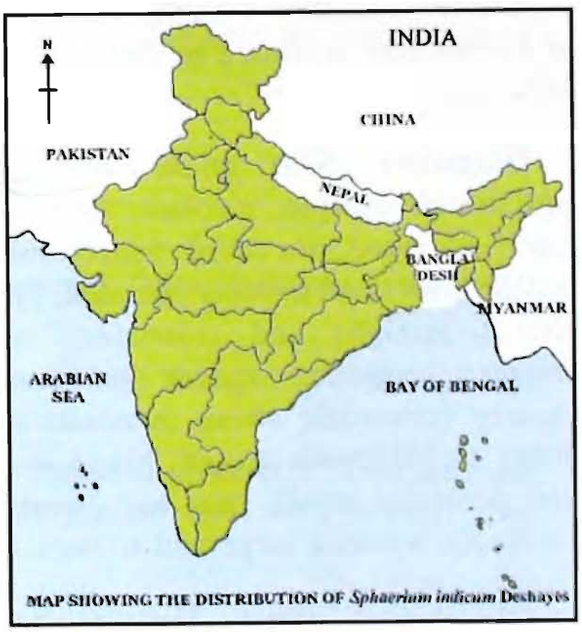
Fig. 277. B. Interior view of ***Sphaerium indicum*** Deshayes

Type location : National History Museum, London.

Latest name and Reference : *Sphaerium indicum* : Mitra, Dey and Ramakrishna, 2005, *Fauna of Andhra Pradesh, State Fauna Series*, 5(Part-5), p. 219. *Zool. Surv. India*

Diagnosis : Shell small, ovately rhomboid, inequilateral with finely concentric striae; anterior end rounded, posterior end obtusely truncate; right valve with a well developed cardinal, sometimes with a reduced second cardinal; one laterals well developed and less curved; Mantle thin, without papillae at the edge.

Distribution : India : Throughout Indian Plains, Himalayas.



Sphaerium kashmirensis Prashad, 1937

1937. *Sphaerium kashmirensis* Prashad, *Rec. Indian Mus.*, **39(3)** : 276, text fig. 1. Type locality : Wular Lake, Kashmir, altitude 5,180 ft, dredged in 0.5-10 meter depth.

1968. *Sphaerium kashmirensis* : Rajagopal and Subba Rao, *Proc. Symposium on Mollusca,* Part I, : 150.

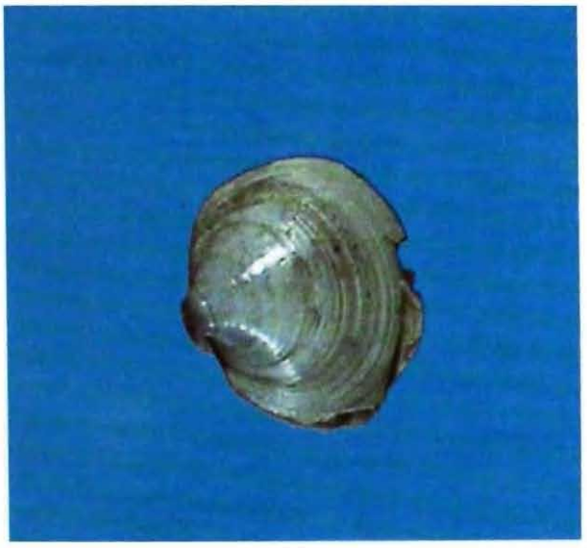
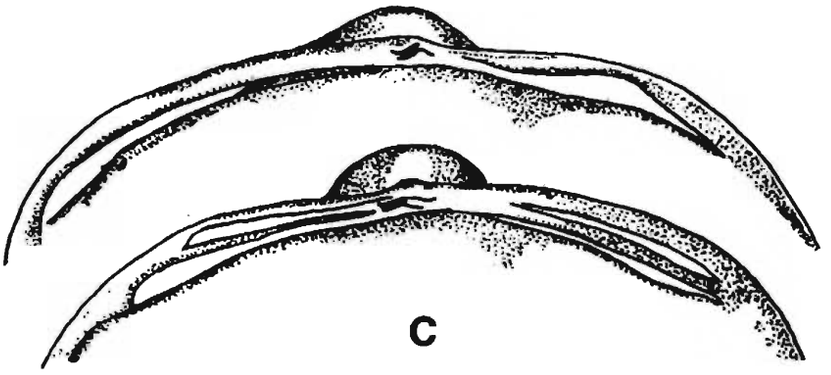
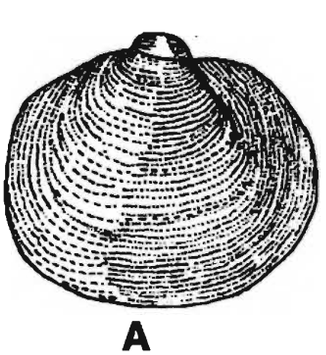


Fig. 278. A. Exterior view of *Sphaerium kashmirensis* Prashad (Type)

Fig. 278. B. Interior view of *Sphaerium kashmirensis* Prashad (Type)





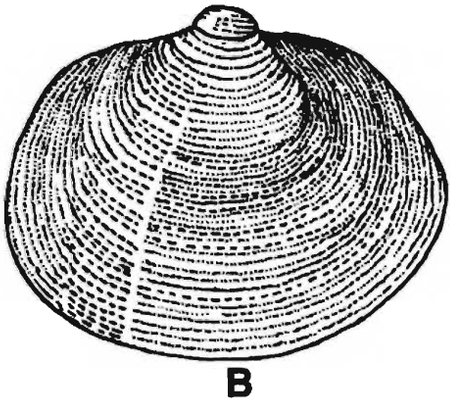


Fig. 279. A. Interior view of ***Sphaerium kashmirensis*** Prashad
Fig. 279. B. Exterior view of ***Sphaerium kashmirensis*** Prashad
Fig. 279. C. Interior view of hingline of ***Sphaerium kashmirensis*** Prashad

Type location : National Zoological Collection, ZSI Regd. No. M 16951/2.

Latest name and Reference : *Sphaerium (Sphaerium) kashmirensis* : Subba Rao, 1989, *Handbook of Freshwater Molluscs of India*, p. 213, figs. 608-610.

Diagnosis : Shell moderately thick, subquadrate, subequilateral, swollen; umbone prominent, incurved and tumid; anterior half of the dorsal margin short, almost straight, posterior part somewhat longer, markedly sloping; anterior margin curved, slightly arched at end; posterior margin slightly arched in the upper end and then sharply truncated; ventral margin very convex; sculpture with well marked, closely situated concentric striae; epidermis light olive colour with yellowish margin, shining.

This species appears to be allied to *S. montanum* Canefri, but differs from it by being relatively shorter, with its straighter anterior and posterior margins, sculpture more strongly developed.

Distribution : India : Kashmir.

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GLOSSARY

Acuminate : pointed

Angular : cornered, two surface meeting at an angle

Angulate : with angular profile

Aperture : opening of body whorl

Apex : starting point of shell growth/ top of gastropod shell

Arcuate : curved or arched

Attenuate : slenderly tapering, often to a point

Axial : longitudinal, following the direction of the axis of shell

Base : the last formed part of the gastropod shell

Beak : raised part on the dorsal margin of the bivalve shell valves.

Biconic : tapering at both ends

Bifurcate : divided into two branches

Bilateral symmetry : left side exact counter part of right side

Body whorl : the largest or lowermost whorl

Calcareous : made of lime

Callus : a thick / thin layer of shelly substance, usually smooth, glossy, often transparent

Cancel late : lattice like ornament formed when ridges or threads meet at right angles

Carinate : with a strong spiral ridge

Columella : part of aperture margin which contributes to the vertical axis of the shell

Columellar fold : fold or projection on columella

Concave : inside curvature

Concentric : growing in a series of concentric layers

Conical : distinctly higher than wide, spire tapered and nearly flat sides, with a sharpe apex

Convex : outside curvature

Cord : a ridge, usually spiral, thicker than the thread

Corneous : made of chitin (non calcareous substance)

Corrugated : wrinkled alternating ridges and furrows

Crenulate : regularly notched or beaded

Cusp : largest elevations of the lateral and pseudocardinal teeth

Decollate : missing of upper most whorl

Decussate : sculpture covering at acute angles

Denticulate : with small teeth

Depressed : broader than high / low

Dextral : aperture on the right when the shell held with its aperture towards the observer

Dioecious : male and female individuals are separate

Discoid : coiled in horizontal plane

Discoidal : disc like

Dorsum : rear side (behind aperture) of gastropod shell

Elliptical : having the form of an ellipse

Elongate : extending length wise

Endemic : restricted to particular geographic area

Furrow : groove or channel

Fusiform : spindle shaped

Globose : heights of the both the entire shell and its aperture about equal to their respective Widths

Granulose : covered with small raised pimples

Growth line : a fine or coarse, raised line defining a temporary pause in the growth of the shell

Hinge : apposing single lamella in one value articulate with a pair of complementary lamellae in the apposing valve.

Imperforate : shell without umbilicus

Impressed : indeted or sunken

Incision : grooved

Inflated : swollen, ventricose

Inner lip : the opposite wall of outer lip (edge of aperture)

Iridecent : Prismatic Coloration; exhibiting like the rainbow.

Keel : more or less sharp edge

Knob : tubercle

Lamellate/Lamellose : covered with scales or thin plates

Lip : inside or outside edge of the aperture of gastropod shell

Lirate : with lirae

Liration : sculpture with fine lines or grooves

Mantle : a fleshy lobe, which secrete the shell and lies inside of shell wall

Margin : shell edge

Multispiral : comprising of many whorls (more than four)

Node : a lumpy protuberance, smaller than tubercle

Nodule : a knob, smaller than node

Notch : the end part of the tube or gutter at the front end of the aperture to hold the front siphon of gastropod shell

Nucleus : the earliest formed part

Obsolete : weak or almost absent

Operculum : aperture closed by flat oblong plate when the animal completely withdrawn into shell

Orifice : a cavity or opening

Outer lip : edge of aperture:

Ovate : height of the shell slightly greater than its width, the aperture also higher than wide (egg shaped)

Papillae : nipple like extensions of mantle

Parietal : region of the shell above columella

Parietal margin: margin of shell above columella

Paucispiral : comprising of few whorls

Pedal retractors : muscle which withdraws foot

Perforate : shell with umbilicus

Periostracum : outer thin organic layer of shell

Peristome : edge of aperture

Peurothetic : Attached to substratum by one valve

Plicae : fold or plait

Plicate : folded or plaited

Punctuate : dotted or spotted

Pustule : A blister like prominence

Rib : a continuous elevation of shell surface

Riblet : continuous elevations of the shell surface, subordinate to ribs

Rudimentany : Vestigial

Septa/Septum : partition of shell

Sinistral : the aperture on the left when the shell is held with its aperture towards observer

Sinuous : gently waved

Siphon : tubular extension of mantle through which water enters or leaves mantle cavity

Siphonal canal/notch : the tube or gutter at the front (lower) end of aperture, to hold the front siphon of gastropod

Spine : a blunt or sharp projection

Spinose : ornamented with spines

Spiral : longitudinal, running along the whorl in the direction of growth

Spiral line : line coiling about a central axis

Spiral thread : thickening area on spiral zone

Spire : the part of shell projecting above the aperture

Striae : fine transverse sculpture

Sulcus : a furrow or groove

Sutural coronation : bead or thickened area on suture

Suture : line of attachment between two whorls

Teeth/Tooth : pointed or blunt structures inside the outer or inner lip of gastropod shell

Transverse : right angle to the axis or length of shell

Trigonal : triangular in form

Truncate : cut off and generally squared

Tubercle : a large rounded protuberance

Tumid : swollen, enlarge

Umbilicate : naval like, with depressed cavity

Umbilicus : a cavity present in the axis of shell and adjacent to aperture

Varices : Surface of shell marked by many growth lines or fine ridges

Vertical : going in the direction of the apex to the base of gastropod shell

Whorl : Turns of the spiral of shell

Wing : The dorsal, thin flat extension of the posterior slope of bivalves

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